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# *Idaho Hazardous Waste Management Act/ Resource Conservation and Recovery Act Closure Plan for Idaho Nuclear Technology and Engineering Center Tanks WM-184, WM-185, and WM-186*

DOE/ID-11067

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Portage Environmental

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Idaho Operations Office

# ABSTRACT

This document presents the plan for the closure of the Idaho Nuclear Technology and Engineering Center Tank Farm Facility Tanks WM-184, WM-185, and WM-186 in accordance with Idaho Hazardous Waste Management Act/Resource Conservation and Recovery Act interim status closure requirements. Initial closure activities for Tanks WM-182 and WM-183 served as a proof-of-process demonstration of the waste removal, decontamination, and sampling techniques for the closure of WM-184, WM-185, and WM-186. Such an approach was prudent because of the complexity and uniqueness of the Tank Farm Facility closure. This plan uses the same closure strategy as that used for Tanks WM-182 and WM-183. This document describes the closure units, objectives, and compliance strategy as well as the operational history and current status of the tanks. Decontamination, closure activities, and sampling and analysis will be performed with the goal of achieving clean closure of the tanks. Coordination with other regulatory requirements, such as U.S. Department of Energy closure requirements, also is discussed.

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# ACRONYMS

| | |
|---|---|
| ANOVA | analysis of variance |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| CFR | Code of Federal Regulations |
| CPP | Idaho Chemical Processing Plant |
| DEQ | Idaho Department of Environmental Quality |
| DOE | Department of Energy |
| DOE-ID | Department of Energy Idaho Operations Office |
| DVB | diversion valve box |
| EPA | Environmental Protection Agency |
| FFA/CO | Federal Facility Agreement and Consent Order |
| FR | Federal Register |
| HEPA | high-efficiency particulate air |
| HLW | high-level waste |
| HWMA | Hazardous Waste Management Act |
| IDAPA | Idaho Administrative Procedures Act |
| IDHW | Idaho Department of Health and Welfare |
| INEEL | Idaho National Engineering and Environmental Laboratory |
| INTEC | Idaho Nuclear Technology and Engineering Center |
| IWTS | Integrated Waste Tracking System |
| *M* | Molar |
| NWCF | New Waste Calcining Facility |
| OU | operable unit |
| PE | professional engineer |
| PEW | process equipment waste |
| RCRA | Resource Conservation and Recovery Act |

| | |
|---|---|
| RI/FS | remedial investigation/feasibility study |
| ROVER | Space Nuclear Propulsion Program |
| RWMC | Radioactive Waste Management Complex |
| TFF | Tank Farm Facility |
| UCL | upper confidence limit |
| WAG | waste area group |
| WINCO | Westinghouse Idaho Nuclear Company |

# Idaho Hazardous Waste Management Act/ Resource Conservation and Recovery Act Closure Plan for Idaho Nuclear Technology and Engineering Center Tanks WM-184, WM-185, and WM-186

## 1. INTRODUCTION

Under the terms of the 1992 Consent Order (and subsequent modifications) between the Idaho Department of Health and Welfare[a] (IDHW) and the U.S. Department of Energy (DOE) (IDHW 1992), DOE must permanently cease use of the tanks in its Tank Farm Facility (TFF) at the Idaho National Engineering and Environmental Laboratory (INEEL) or bring the tanks into compliance with secondary containment requirements as set forth by Idaho Administrative Procedures Act (IDAPA) 58.01.05.009 (2002) (40 Code of Federal Regulations [CFR] 265.193, 2002). The Consent Order (IDHW 1992) further specifies that this compliance cannot be achieved through an equivalency demonstration or by obtaining a variance as provided by IDAPA 58.01.05.009 [40 CFR 265.193(d)(4) and (h)]. DOE plans to close the TFF tanks because high radiation fields would make compliance with secondary containment requirements difficult, and a need for such storage is not evident after 2012.

The TFF includes eleven belowground 300,000-gal and 318,000-gal tanks (hereinafter referred to as 300,000-gal tanks) and four 30,000-gal tanks (see Figure 1). The 300,000-gal tanks are numbered WM-180 through WM-190. The second modification to the Consent Order specifies that DOE must cease use of Tanks WM-182, WM-183, WM-184, WM-185,[b] and WM-186 by June 30, 2003, and the remaining tanks by December 31, 2012. Ceasing use of the tanks, as defined in the Consent Order, means that DOE must empty the tanks down to their heels (that is, the liquid level remaining in each tank must be lowered to the greatest extent possible by the use of existing transfer equipment) (IDHW 1998). According to the Idaho Hazardous Waste Management Act of 1983 (HWMA) and the Resource Conservation and Recovery Act (RCRA), the TFF is an interim status hazardous waste management unit (State of Idaho 1983; 42 USC 6901, 1976). Because of this, the requirements of 40 CFR 265 (2002) apply to the TFF closure (rather than 40 CFR 264 [2002]).

The TFF tanks will be closed in phases; the closure of Tanks WM-182 and WM-183 is the first phase and is in progress. Tanks WM-184, WM-185, and WM-186 will be closed in phase two. The TFF will continue to operate until 2012 while various parts of the facility are being closed. The final closure of any component of the TFF will not be complete until all the tanks have been closed and the remedial investigation/feasibility study (RI/FS) for Operable Unit (OU) 3-14 (Tank Farm Soils) is completed. The final closure plan will address closure and any required post-closure care of the TFF. Tank closure plans are written with a goal of clean closure; however, a decision to close the unit as a landfill or as clean closure will not be made until final closure.

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a. On July 1, 2000, the Division of Environmental Quality, a division within the Idaho Department of Health and Welfare, was elevated to the Idaho Department of Environmental Quality (DEQ). This department now oversees the implementation of the Consent Order.

b. The Consent Order allows Tank WM-185 to be used as an emergency spare tank.

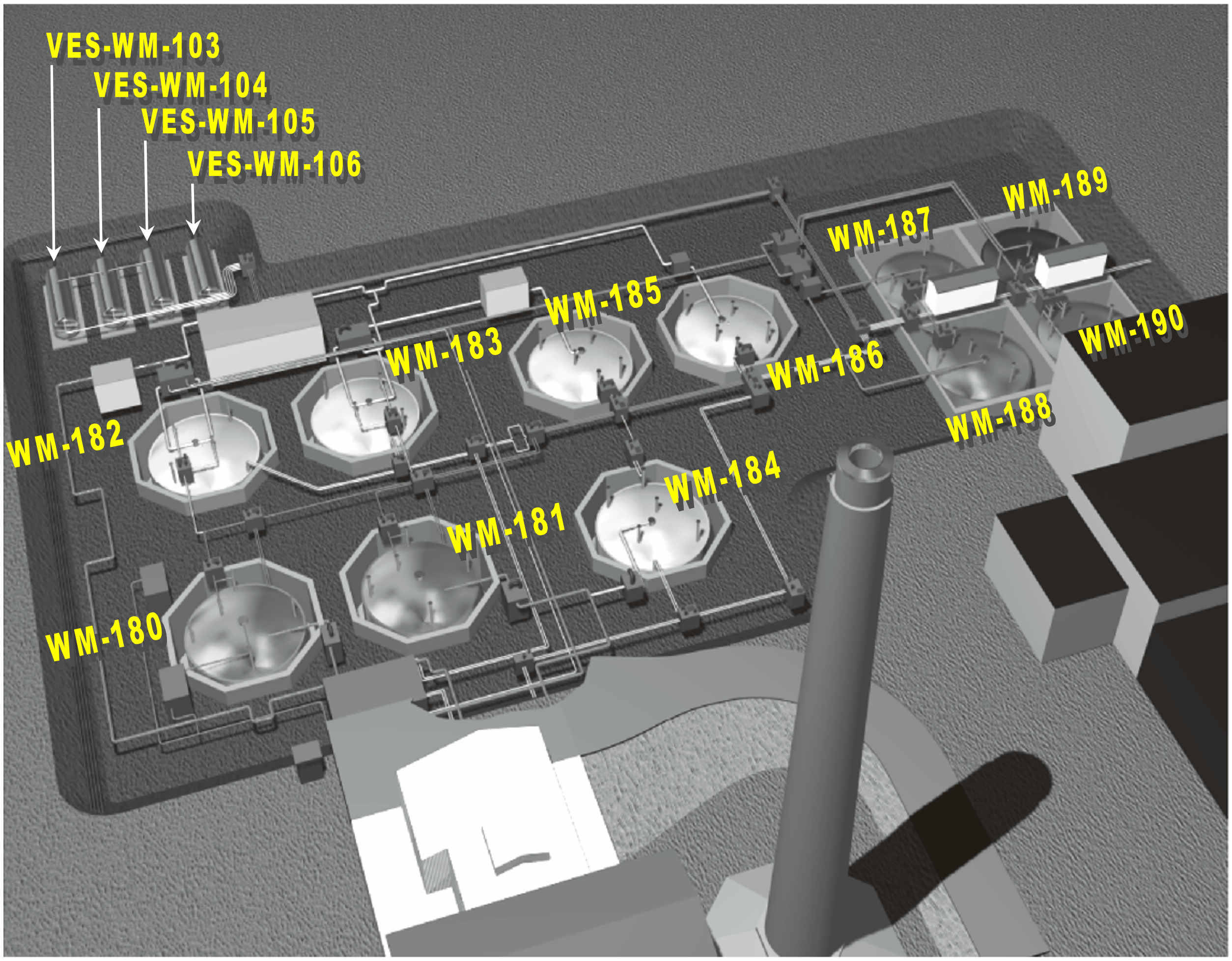



Figure 1. Conceptual overview of the TFF.

Two significant releases from TFF piping systems to surrounding soils have occurred. No releases have occurred from the tanks to environmental media. These releases are subject to investigation and remediation as necessary under the INEEL Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) program (42 USC 9601, 1980) as described in the *Federal Facility Agreement and Consent Order* (FFA/CO) (IDHW, Environmental Protection Agency [EPA], and DOE Idaho Operations Office [DOE-ID] 1991).

This closure plan addresses closure of Tanks WM-184, WM-185, WM-186, including the ancillary equipment, pursuant to the Idaho HWMA and RCRA only. Because the tanks also contain radioactive constituents regulated by DOE, the tanks also must comply with DOE closure requirements; a DOE closure plan will be developed separately. The DOE requirements are found in DOE Order 435.1, “Radioactive Waste Management” (DOE 2001a), and its associated manual and guidance (DOE 2001b; DOE 1999a). DOE orders are discussed further in Section 5.1. All closure activities will be closely coordinated to ensure compliance with Idaho HWMA/RCRA and other DOE orders.

This document is a plan for the closure of TFF Tanks WM-184, WM-185, and WM-186 as required by IDAPA 58.01.05.009 and 40 CFR Part 265, “Interim Status Standards for Owners and

Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities." This plan describes a strategy for clean closure (removal or decontamination of all waste residues) of the tanks to site-specific action levels. In addition, IDAPA 58.01.05.009 (40 CFR 265.197(c)(1), 2002) specifies that both a closure plan for clean closure and a contingent closure plan for closure of the tanks as a landfill must be prepared for tank systems that do not have adequate secondary containment. Because the Notice of Noncompliance Consent Order states that the TFF tanks do not have RCRA-compliant secondary containment (IDHW 1992), the contingent landfill closure plan is presented in *Contingent Landfill Closure and Post-Closure Plan for Idaho Nuclear Technology and Engineering Center Tanks in the Tank Farm Facility* (DOE-ID 2003).

## 1.1 Tank Farm Description

The TFF is part of the INEEL's Idaho Nuclear Technology and Engineering Center (INTEC), formerly the Idaho Chemical Processing Plant (CPP). The TFF includes eleven belowground 300,000-gal and four belowgrade 30,000-gal stainless-steel tanks. Aboveground structures in the TFF include the TFF Control House (Building CPP-628), the Computer Interface Building (CPP-618), valve boxes, and tank and vault sump riser covers. The condenser pits are the TFF belowground structures. The Computer Interface Building is only used to monitor the closure processes and is not otherwise associated with any closure activities. The TFF Control House contains piping that is associated with the TFF. Portions of the piping associated with Tanks WM-184, WM-185, and WM-186 will be decontaminated and capped or otherwise sealed during this closure. The condenser pits, valve boxes, and tank and vault sump riser covers will be closed during closure of WM-184, WM-185, and WM-186. A perimeter fence encloses the TFF on the west, north, and east sides. Buildings border the east side. Gates are located on the west, north, and south sides of the TFF (INEEL 1998). A description of the INTEC TFF and a general description of the hydrogeologic conditions are provided in Appendix A.

The TFF was used to store liquid wastes generated by spent nuclear fuel reprocessing operations, ancillary operations, and decontamination wastes from reprocessing facilities at INTEC. Construction of the TFF began in 1951 with Tanks WM-180 and WM-181. Tanks WM-182 through WM-184 were completed in 1955, Tanks WM-185 and WM-186 were completed in 1957, and Tanks WM-187 and WM-188 were completed in 1959. The last tanks, WM-189 and WM-190, were constructed in 1964. Construction of the four 30,000-gal tanks was completed in 1955. The 30,000-gal tanks were taken out of service in 1983, and the tank inlets have been cut and capped (DOE-ID 2000a).

Eight of the large tanks (WM-180, WM-182, WM-183, WM-185, WM-187, WM-188, WM-189, and WM-190) contain stainless-steel cooling coils to minimize tank corrosion. Tanks WM-181, WM-184, and WM-186 do not have cooling coils. Risers provide access to each tank. Each tank has four or five 12-in. diameter risers. Tanks WM-184 through WM-188 also have one 18-in. diameter riser with steam jets; Tanks WM-189 and WM-190 have two 18-in. risers. Most risers also have installed equipment, such as radio frequency probes for level measurement, corrosion coupons, or waste transfer equipment (steam jets and airlifts). Two steam jets are located inside each tank, except for Tanks WM-189 and WM-190. These two tanks each have one steam jet and one airlift pump. A single steam jet can transfer waste out of a tank at approximately 50 gpm, and an airlift can transfer waste out of a tank at approximately 35 gpm (INEEL 2000a).

Each 300,000-gal tank is contained in a concrete vault. The bottoms of the vaults are approximately 45 ft belowground and are configured in one of three basic designs: monolithic octagonal, pillar and panel octagonal, or monolithic square. The 6-in. thick concrete vault roofs are covered with approximately 10 ft of soil to provide radiation shielding. Tanks WM-184, WM-185, and WM-186 are contained in pillar and panel octagonal vaults. Because vaults of this design were constructed with prefabricated components, these vaults are not considered as robust as vaults of monolithic design (INEEL 2000a), and are therefore required by the Consent Order to be taken out of service first (IDHW 1992).

Liquid waste transfers to, from, and between the tanks are managed through a system of piping, valves, and diversion boxes. The liquid waste is routed through waste transfer valves located in underground, stainless-steel-lined concrete boxes, referred to as valve boxes. Liquids resulting from decontamination efforts or leakage of valve boxes and piping encasements (secondary containment for piping) are drained to tanks, vaults, or diversion boxes (INEEL 1998).

A centralized vessel off-gas system is designed to maintain negative pressure and balance airflow in each of the 300,000-gal tanks (INEEL 1999). The vessel off-gas piping consists of 10-in. diameter underground piping from the tanks to condenser pits and then to blowers located in CPP-605; the blowers discharge air to the INTEC main exhaust stack. The components of the vessel off-gas system associated with WM-184, WM-185, and WM-186 cannot be closed until each of the tanks is grouted because of the safety basis defined in the TFF SAR.

## 1.2 Waste Description

Wastes stored in the TFF tanks exhibit the hazardous characteristics of corrosivity (Hazardous Waste Number D002) (40 CFR 261 Subpart D, 2002). Historical data indicate the TFF waste exhibited the characteristic of toxicity for lead (D008), cadmium (D006), chromium (D007), and mercury (D009). Also associated with the waste are four RCRA-listed hazardous waste numbers (Gilbert and Venneman 1999):

- F001 (carbon tetrachloride; 1,1,1-trichloroethane; trichloroethylene)
- F002 (carbon tetrachloride; tetrachloroethylene; 1,1,1-trichloroethane; trichloroethylene)
- F005 (benzene, carbon disulfide, pyridine, toluene)
- U134 (hydrofluoric acid).

## 1.3 Tank Farm Status

The TFF is currently used to store sodium-bearing waste from activities associated with previous reprocessing, ancillary operations, and decontamination activities and receive newly generated liquid waste from INTEC plant operations and decontamination activities. To meet the Settlement Agreement and subsequent court order with the State of Idaho (State of Idaho, DOE, and Department of the Navy 1995), all non-sodium-bearing-waste liquid HLW was converted to calcine by February 1998 (DOE 2002). Table 1 summarizes the volume of waste in the 300,000-gal tanks as of December 31, 2002.

## 1.4 Maximum Inventory of Wastes

The provisions in IDAPA 58.01.05.009 (State of Idaho 1983) (40 CFR 265.112(3), 2001) require that a closure plan include an estimate of the maximum inventory of hazardous wastes ever onsite over the active life of the facility. This section discusses the reprocessing operation and wastes generated, tank usage, history of operations, and the maximum inventory in each of Tanks WM-184, WM-185, and WM-186. The maximum inventory in each tank was administratively controlled at 285,000 gal. Details about waste composition and historical use of Tanks WM-184, WM-185, and WM-186 are located in Section 1.4.4.

Table 1. Tank volumes as of December 31, 2002.

| Tank | Volume (gal)[a] | Tank | Volume (gal)[a] |
|---|---|---|---|
| WM-180 | 276,000 | WM-186 | 19,700 |
| WM-181 | 23,000 | WM-187 | 229,000 |
| WM-182 | 6,400 | WM-188 | 210,100 |
| WM-183 | 4,500 | WM-189 | 280,100 |
| WM-184 | 5,100 | WM-190 | 500 |
| WM-185 | 12,900 | **Total** | **1,067,300** |

a. Source: Letter from J. H. Valentine, INEEL, to Brian R. Monson, DEQ, 2003, "Contract No. DE-AC07-99ID13727-Status of Consent Order Activities," CCN 39424, January 28.

### 1.4.1 Reprocessing Operations and Wastes Generated

Reprocessing operations at INTEC took place from 1952 until they were phased out in 1992. These operations used a three-cycle solvent extraction process to recover enriched uranium from spent nuclear fuel. The spent nuclear fuel was dissolved in hydrofluoric or nitric acid to form a uranyl nitrate solution suitable for solvent extraction. The fuel types included aluminum, zirconium, stainless steel, graphite, and custom. The fuel dissolution process varied depending on the type of fuel to be reprocessed. The enriched uranium was then extracted using a three-step solvent extraction process. The solution remaining after the first extraction cycle was considered high-level waste (HLW) and was stored in the TFF. The liquid remaining from the second and third extraction cycles, as well as solutions resulting from decontamination activities, were stored separately in the TFF. This waste is generally referred to as sodium-bearing waste because of its relatively high sodium content (when compared to first-cycle wastes) as a result of decontamination activities. Although reprocessing operations have ceased, the TFF continues to receive waste from INTEC plant operations and decontamination activities.

### 1.4.2 Fuel Dissolution

Generally, five types of dissolution processes were used during reprocessing because of the varied nature of fuel types: aluminum, zirconium, stainless steel, graphite, and custom. In the aluminum dissolution process, aluminum-based fuels were dissolved in a nitric acid solution in the presence of a mercuric nitrate catalyst. Zirconium-based fuels were dissolved using the fluorinel dissolution process. This process used hydrofluoric and nitric acids, aluminum nitrate, and the soluble nuclear poisons of cadmium and boron. Stainless-steel fuels were dissolved in nitric acid while a direct electrical current passed through the fuel in the electrolytic dissolution process. The Space Nuclear Propulsion Program (ROVER) dissolution process was used to dissolve graphite fuels. ROVER fuels consisted of either an uncoated or pyrolytic-carbon-coated graphite matrix that contained uranium dispersed throughout as uranium dicarbide fuel particles. These fuels were first burned in oxygen to remove the graphite. The uranium materials were then dissolved in hydrofluoric and nitric acids. Custom processing in specially-designed, pilot-plant-type equipment with material-specific dissolvents was used for nuclear material that was incompatible with established dissolution processes. For example, those fuels with nontraditional cladding materials, material impurities, excessively high radiation levels, or small amounts of recoverable fissile material required custom fuel processing methods (Westinghouse Idaho Nuclear Company [WINCO] 1986).

### 1.4.3 Fuel Extraction

In the first-cycle extraction process, uranium was extracted from the uranyl nitrate solution into a solution of tributyl phosphate in dodecane. The aqueous raffinate stream from this extraction, which included the fission products, was sent to the TFF waste tanks unless the uranium concentration remained high enough for further extraction (WINCO 1986).

The second- and third-cycle extraction processes used the hexone extraction process to purify the uranium product from the first-cycle extraction. The process used the solvent methyl isobutyl ketone (hexone) to separate the uranium from residual fission products and transuranic elements such as neptunium and plutonium. The waste material containing the transuranics and fission products was generally evaporated to reduce its volume before being sent to the TFF for calcination (WINCO 1986).

### 1.4.4 Waste Types and Composition

The types of radioactive liquid waste generated at INTEC can be separated into eight basic categories, as listed below. Table 2 summarizes the typical chemical compositions of these waste types.

- Aluminum waste from the dissolution of aluminum fuels in nitric acid
- Zirconium fluoride waste from the dissolution of zirconium fuels in hydrofluoric acid
- Coprocessing waste that results when dissolver product from aluminum fuel dissolution is used as the complexing agent for zirconium dissolver product before introduction to the extraction system
- Fluorinel waste from the dissolution of zirconium fuels in hydrofluoric acid and nitric acid
- Stainless-steel waste from the electrolytic dissolution of stainless-steel fuels in nitric acid
- ROVER waste from the dissolution of graphite-type fuels in hydrofluoric acid and nitric acid
- Custom-processing wastes that are the second- and third-cycle raffinates resulting from processing custom fuels
- Sodium-bearing waste that results from process equipment waste (PEW) evaporator bottoms and sodium-bearing decontamination solutions.

All first-cycle raffinates were acidic, with a hydrogen-ion concentration between 1 and 3 molar (*M*). Radionuclides in the first-cycle raffinates produced a typical radioactivity level in the stored wastes from 5 to 40 Ci/gal (INEEL 1998). The raffinates from zirconium dissolution and coprocessed zirconium and aluminum dissolution were fluoride-bearing wastes. The first-cycle raffinates from the dissolution of aluminum and stainless-steel fuel were non-fluoride bearing (WINCO 1986).

The chemical and radiochemical composition of the wastes and the amount of heat generated vary with the type of fuel being processed, decay time before processing, and fuel burnup. Chemicals in concentrations up to 4 *M* and large quantities of fission products are present. The major chemicals present are aluminum and nitrate in the non-fluoride waste, and aluminum, zirconium, fluoride, and nitrate in the fluoride waste (INEEL 1998).

The composition of second- and third-cycle raffinates is essentially the same for all fuel types processed. The fission product activity in these wastes is low enough that little heat is generated, making cooling unnecessary. The principal nuclides present are $^{137}Cs$, $^{90}Sr$, and $^{238}Pu$. The predominant chemicals

Table 2. Typical chemical composition of various waste types.[a]

| Waste Type | Aluminum ($M$) | Zirconium ($M$) | Fluorinel ($M$) | Stainless Steel ($M$) | Sodium ($M$) |
|---|---|---|---|---|---|
| Acid (H+) | 1 | 1.5 | 1.9 | 2.5 | 1.2 |
| Nitrate | 4.6 | 2.6 | 2.3 | 3 | 4.6 |
| Fluoride | 0 | 2.5 | 2.7 | 0 | 0.05 |
| Aluminum | 1.3 | 0.6 | 0.3 | 0.65 | 0.6 |
| Zirconium | 0 | 0.4 | 0.4 | 0.01 | 0.0 |
| Boron | 0.01 | 0.15 | 0.2 | 0 | 0.01 |
| Cadmium | 0 | 0 | 0.13 | 0 | 0.0 |
| Sulfate | 0.01 | 0 | 0.08 | 0.06 | 0.06 |
| Sodium | 0.04 | 0.04 | 0.03 | 0.01 | 1.6 |
| Potassium | 0.003 | 0.007 | 0.001 | 0 | 0.2 |
| Iron | 0.01 | 0.01 | 0.01 | 0.06 | 0.02 |
| Chromium | 0 | 0 | 0 | 0.01 | 0.003 |
| Calcium | 0.06 | 0.02 | 0.02 | 0.005 | 0.04 |

a. From *Idaho Nuclear Technology and Engineering Center Safety Analysis Report* (INEEL 1999).

in the second- and third-cycle combined waste are aluminum and nitrate. The waste is acidic, with a hydrogen ion concentration between 0.1 and 1.6 $M$ (INEEL 1998).

Each of the three tanks (WM-184, WM-185, and WM-186) has a different waste storage history. The maximum inventory of each tank was administratively limited to 285,000 gal. Construction of Tank WM-184 was completed in 1955; construction of Tanks WM-185 and WM-186 was completed in 1957 (INEEL 2000b; Palmer et al. 1998). Figures 2, 3, and 4 show the historical volumes in Tanks WM-184, WM-185, and WM-186, respectively.

The sources and quantity of tanks solids are estimated from process history, recent tank-heel sampling, and in-tank video inspections. The actual amount of solids varies in each tank observed. However, based on tank filling history and a comparison of inspected tanks, solid quantities and radiological compositions have been conservatively estimated and should be bounded by this estimate (Tyson 2002). Waste quantities used to calculate inventories in the 300,000-gal tanks were based upon 1 in. of sludge (25% solids and 75% liquid) and about 1/4 in. or 400 gal of free liquid remaining in each individual tank. The quantity of solids sludge from all tanks is estimated to be about 45,000 gal, containing about 86,000 kg of solids (Poloski 2000).

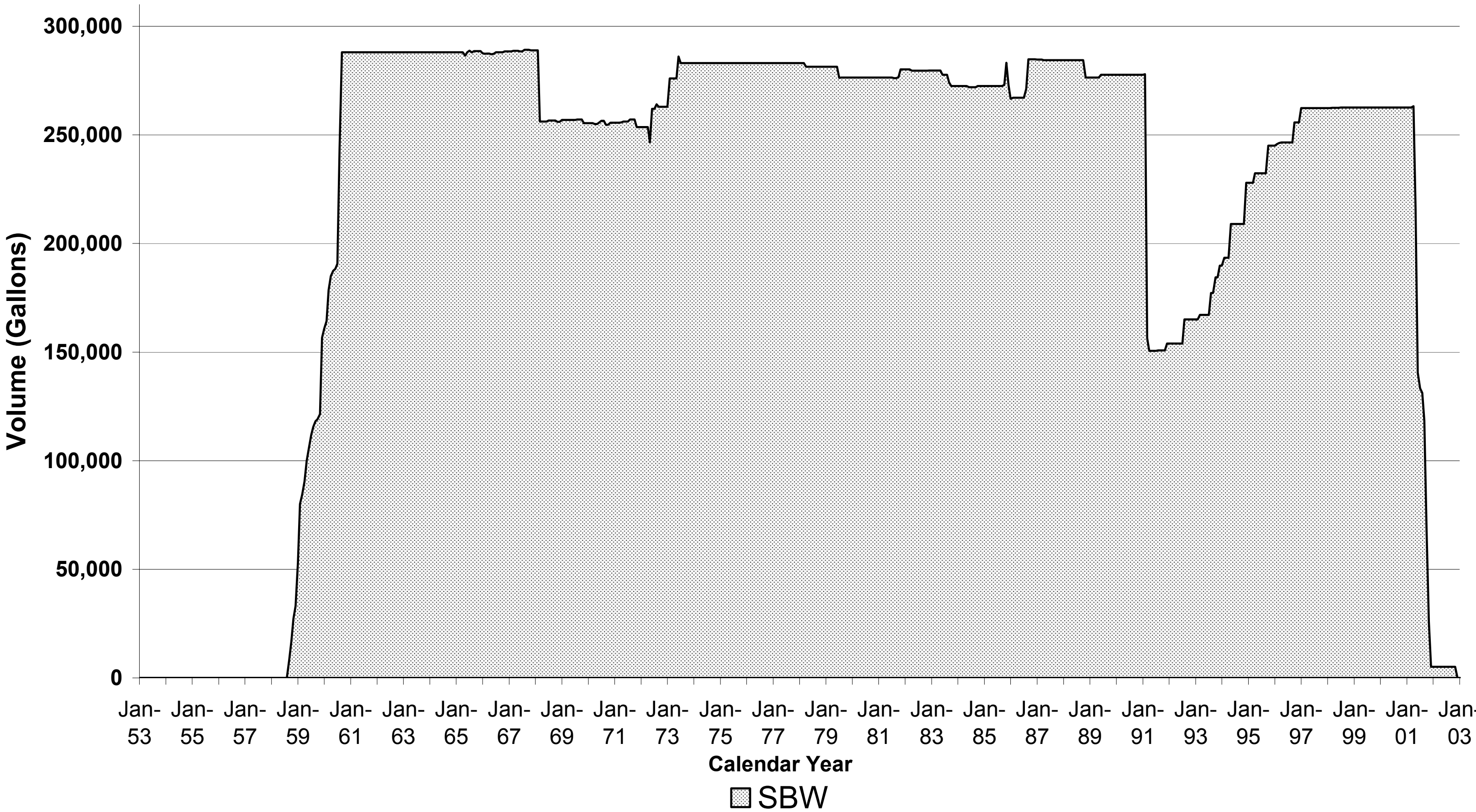



Figure 2. Volumes of waste contained in WM-184.

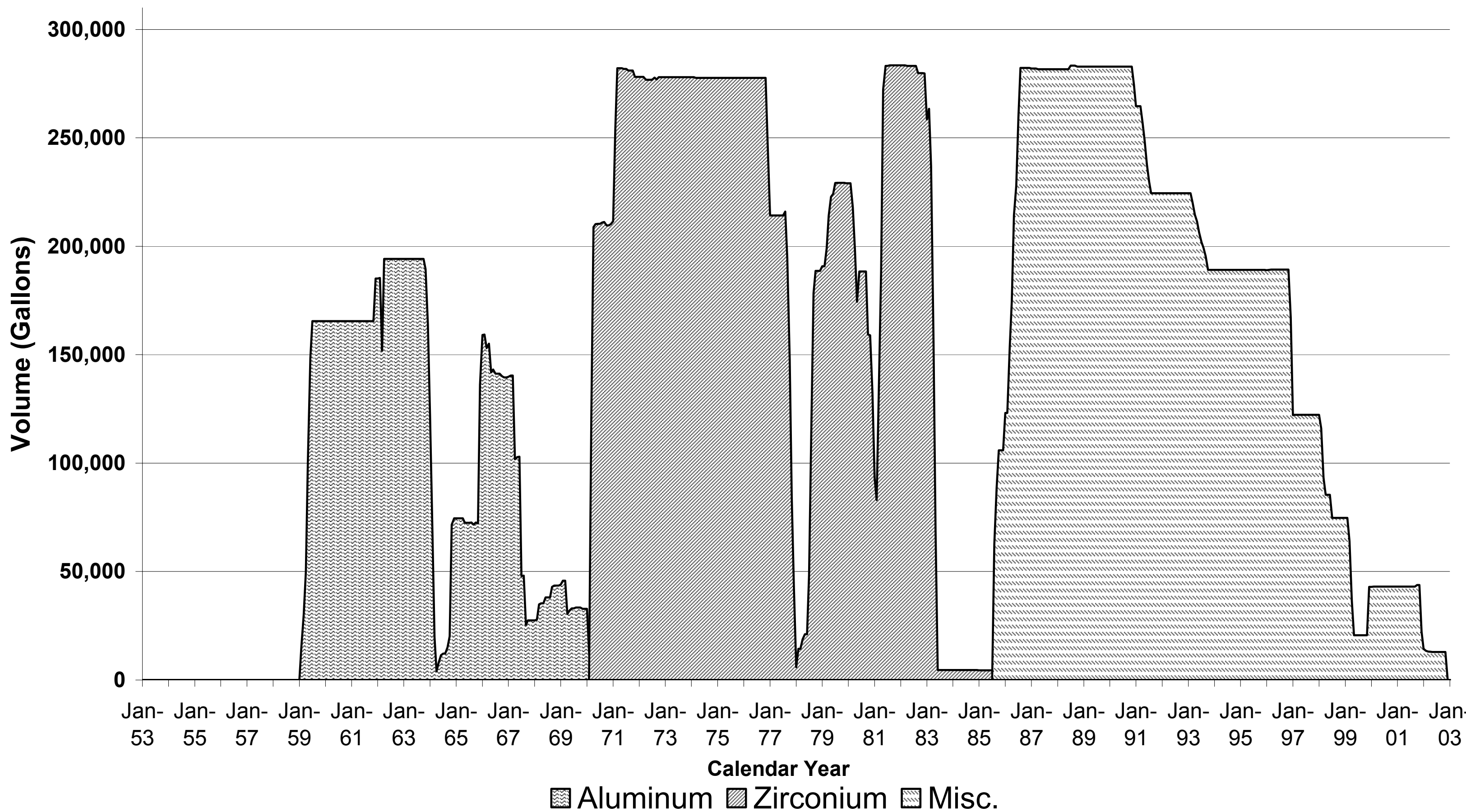



Figure 3. Volumes of waste contained in WM-185.

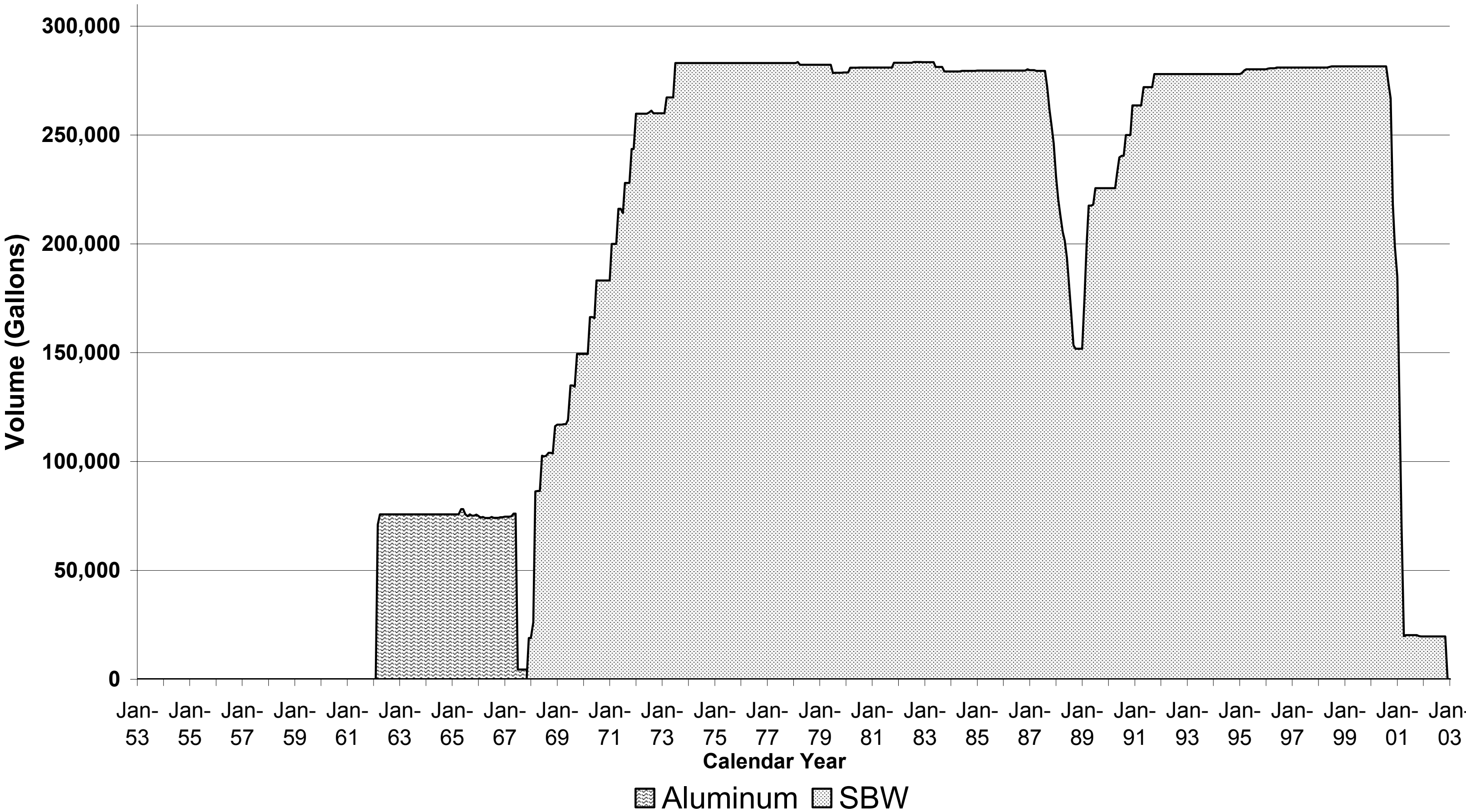



Figure 4. Volumes of waste contained in WM-186.

# 2. CLOSURE OBJECTIVES

This closure plan presents the strategy for clean closure of Tanks WM-184, WM-185, and WM-186 to meet the HWMA/RCRA requirements for cleanup of hazardous constituents only. However, as noted previously, the closure of Tanks WM-184, WM-185, and WM-186 must also meet the requirements for cleanup of radionuclides to meet the intent of DOE orders for HLW systems, specifically DOE Order 435.1. The DOE Tier 1 Closure Plan provided the necessary information for removal of radionuclides (DOE-ID 2003b). Each of these objectives is discussed in greater detail below.

## 2.1 HWMA/RCRA Clean Closure Objectives

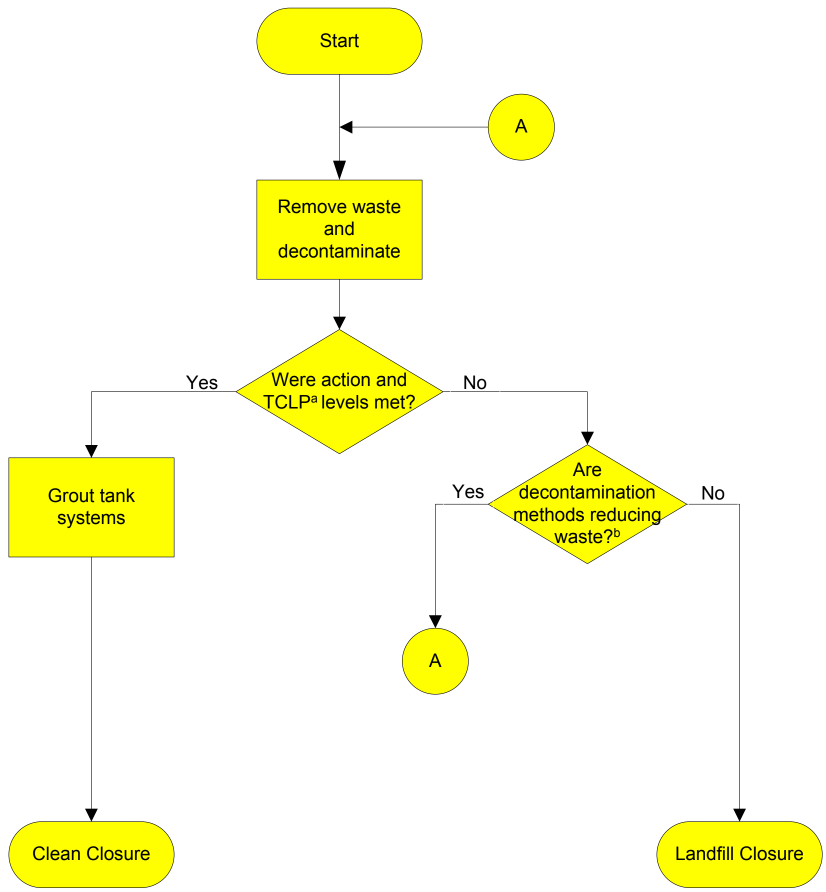
Closure of Tanks WM-184, WM-185, and WM-186 will be performed to meet requirements of both HWMA and RCRA, specifically IDAPA 58.01.05.009 (2002) and 40 CFR 265 (2002). Administrative Rule IDAPA 58.01.05.009 incorporates 40 CFR 265 and all subparts (excluding Subpart R, "Underground Injection," 40 CFR 265.149, "State Assumption of Responsibility," and 265.150, "Use of State-Required Mechanisms") by reference. The objective will be to achieve clean closure of the tanks and tank system components in accordance with 40 CFR 265.110, 40 CFR 265.111, 40 CFR 265.112, and 40 CFR 265.197 (all 2002).

Clean closure is the removal or decontamination of all hazardous wastes from the tank system. Except for hazardous waste and liners, the regulations do not require complete removal of all contamination for clean closure. Rather, some limited quantity of hazardous constituents may remain in the tanks after clean closure if the concentrations of hazardous constituents are below site-specific action levels and are not RCRA hazardous. Tanks WM-184, WM-185, and WM-186 are intended to be clean closed. Section 3 describes compliance with the performance standards in 40 CFR 265.111 and 40 CFR 265.197. Figure 5 shows the steps for HWMA/RCRA closure for Tanks WM-184, WM-185, and WM-186.

Although RCRA closure of a tank system requires investigation and removal or decontamination of associated contaminated soils, the contaminated soils investigation and remediation associated with the WM-184, WM-185, and WM-186 closure will be performed in accordance with CERCLA requirements as described by the FFA/CO (IDHW, EPA, and DOE-ID 1991). The entire TFF will be investigated as part of OU 3-14. The investigation is described in the *Operable Unit 3-14 Tank Farm Soil and Groundwater Phase I Remedial Investigation/Feasibility Study Work Plan* (DOE-ID 2000a). The objectives of the remedial investigation as described in the work plan are to collect data for preparation of a baseline risk assessment and feasibility study. The TFF area contaminated soils and the Snake River Plain Aquifer (the area of the aquifer that lies within the boundaries of the INTEC fence) are the focus of the remedial investigation. A final remedial action for the TFF area soils will be the result of the RI/FS and subsequent Record of Decision.

To define the clean closure standard, site-specific action levels are developed. The methodology for establishing action levels is found in Appendix B. Clean closure is achieved by performing all of the following steps, as shown in Figure 5:

- Remove/decontaminate hazardous waste. All constituents will be decontaminated to less than the toxicity characteristic threshold concentrations (40 CFR 261.24, Table 1, 2002) and the characteristic of corrosivity (40 CFR 261.22, 2002) and will not exhibit the toxicity characteristic. The pH of the residual will be greater than 2 and less than 12.5, as described in 40 CFR 261.22. Threshold concentrations are not used as action levels but rather to demonstrate that waste does not remain in the tanks.




a. TCLP = toxicity characteristic leaching procedure.
b. This decision will be made after all tanks and ancillary equipment have been closed.

Figure 5. Steps for HWMA/RCRA closure for INTEC Tank Farm Facility tanks ancillary equipment and soils.

- Meet the site-specific action levels described in Section 3.2.

- Meet the performance standards of 40 CFR 265.111 (2002). Grouting of the pipes, tanks, vaults, and sumps will meet these performance standards to eliminate need for further maintenance and preclude post-closure escape of any residual contaminants during the post-closure period.

## 2.2 DOE Closure Objectives

The second objective of WM-184, WM-185, and WM-186 closure is to meet the closure criteria of DOE Order 435.1, "Radioactive Waste Management" (DOE 2001a). This DOE closure process is designed to close systems in a manner that is safe and protective of human health and the environment. A Tier 1 DOE closure plan has been prepared to address risks associated with the radiological nature of the tank contents. Before proceeding with the irreversible actions connected to closure, DOE Headquarters will issue an Authorization to Proceed. DOE closure requirements are discussed further in Section 5.1. The proposed methods for hazardous waste, hazardous constituent, and radionuclide removal from the tank systems are the same and are described in Section 4.3.

# 3. CLOSURE REQUIREMENTS AND PERFORMANCE STANDARDS

Closure requirements are specified by HWMA/RCRA as implemented by IDAPA 58.01.05.009 (2002) and 40 CFR Part 265 (2002). The matrix in the following section summarizes closure requirements and the strategy for complying with the requirements.

## 3.1 Compliance Matrix

Table 3 provides a summary of HWMA/RCRA closure requirements for this closure plan, organized by regulatory citation. The table includes a description of how the compliance strategy will meet the requirement and a reference to the section in this closure plan where the strategy is described in more detail. A contingent landfill closure plan has been prepared and will be submitted with this closure plan (DOE-ID 2003).

## 3.2 Action Levels

The action levels established for WM-184, WM-185, and WM-186 will be compared to data gathered after final decontamination of the tanks and ancillary equipment. Final sample results collected from residuals of the tanks and vaults will be used as the concentration term. The concentration term will be established as the 95% upper confidence limit of the mean of samples collected after decontamination. Residuals from the tanks, tank vaults, and valve boxes will be sampled. During the course of closure, the data from these samples will be analyzed by statistical methods to determine if the data from the various locations are from the same population. The statistics tests used will be the Student's t Test and/or analysis of variance (ANOVA). Risks associated with radionuclide residuals are addressed in the DOE closure plans. The action levels for RCRA/HWMA closure are presented in Table 4. The constituents listed in Table 4 are those that could reasonably be expected to exist in the tanks. However, hazardous constituents other than those shown in Table 4 that are detected during confirmation sampling (post decontamination sampling) will be assigned action levels using methodology consistent with that shown in Appendix B.

The action levels were developed by the methodology described in Appendix B. The concentrations of action levels are shown in mg/L. Based on WM-182 and WM-183 decontamination, it is anticipated that the solid removal will be very effective. Solid sampling and analysis will be in accordance with the sampling and analysis plan.

## 3.3 Soils Strategy

Soil contamination is present at the TFF because of historical leaks from tank transfer piping. The tanks have never leaked contents to the environment. RCRA closure of a tank system requires investigation and removal or decontamination of associated contaminated soils. These soils are not part of this plan, however, but are included as part of a CERCLA project. The contaminated soils will be investigated as part of the OU 3-14 RI/FS. The investigation is described in the *Operable Unit 3-14 Tank Farm Soil and Groundwater Phase I Remedial Investigation/Feasibility Study Work Plan* (DOE-ID 2000a).

The alternate strategy for removal and decontamination of the tank systems, which includes soils investigation and decontamination, is proposed because the FFA/CO has established that investigations of Solid Waste Management Unit releases are the responsibility of the CERCLA program (IDHW, EPA, and DOE-ID 1991). The investigation and remediation plans must be final before closure of the entire TFF. The Idaho Completion Project will plan the soil investigation, with input from the INEEL HLW and HWMA/RCRA regulatory programs.

Table 3. HWMA/RCRA closure plan compliance matrix.

| 40 CFR, Part 265, Subpart G (2002)<br>Interim Status Treatment, Storage, and Disposal Facility Standards—Closure and Post-closure | | |
|---|---|---|
| Regulatory Requirement Summary | Compliance Strategy | Section in Plan |
| § 265.110 Applicability | | |
| (a) Sections 265.111 through 265.115 (closure) apply to the owners and operators of all hazardous waste management facilities. | These sections are not applicable to this closure. | See citation in matrix below |
| (b) Sections 265.116 through 265.120 (post-closure care) apply to owners and operators of hazardous waste disposal facilities, waste piles and surface impoundments as required by Sections 265.228 or 265.258, tank systems that are required under Section 265.197 to meet requirements for landfills, and containment buildings as required by Section 265.1102. | Not applicable for clean closure. These sections are addressed in the contingent landfill closure plan (DOE-ID 2003). | See citation in matrix below |
| (c) Section 265.121 applies to owners and operators of units that are subject to the requirements of 40 CFR 270.1(c)(7). | Not applicable for clean closure. This section is addressed in the contingent landfill closure plan (DOE-ID 2003). | See citation in matrix below |
| (d) The Regional Administrator may replace all or part of the requirements of this subpart with alternative requirements for closure. | Not applicable. | NA |
| § 265.111 Closure Performance Standard | | |
| (a) Facility must be closed in a manner that minimizes the need for further maintenance. | The closure strategy results in waste removal and decontamination of Tanks WM-184, WM-185, and WM-186 to action levels to meet clean closure standards, minimizing the need for further maintenance. | 2.1, 3.2, Table 4, 4.2, 4.3 |
| (b) Facility must be closed in a manner that controls, minimizes, or eliminates, to the extent necessary to protect human health and the environment, post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated run-off, or hazardous waste decomposition products to the ground or surface waters or to the atmosphere. | Waste will be removed and the system decontaminated. Only residue that does not exceed the clean closure criteria (action levels) and is not RCRA hazardous will remain in the tank system. Grouting of the tank system will minimize post-closure escape of hazardous constituents, leachate, or hazardous waste decomposition products to the groundwater or to the atmosphere. | 4.2, 4.3 |
| (c) Facility must be closed in a manner that complies with the closure requirements of this subpart, including § 265.197 (tank systems). | The closure performance standard will be met as described above. The requirements of § 265.197 will be met as described later in this matrix. | 4.2, 4.3 |

Table 3. (continued).

| 40 CFR, Part 265, Subpart G (2002)<br>Interim Status Treatment, Storage, and Disposal Facility Standards—Closure and Post-closure | | |
|---|---|---|
| Regulatory Requirement Summary | Compliance Strategy | Section in Plan |
| § 265.112 Closure Plan; Amendment of Plan | | |
| (a) Written plan. This section specifies the conditions under which a written closure plan must be maintained. | DOE is required under the Second Modification to Consent Order (IDHW 1998) to submit a closure plan to DEQ under the requirements of IDAPA 16(now 58).01.05.009 (40 CFR Part 265, Subpart G) for at least one of these tanks (WM-182 through WM-186) on or before December 31, 2000. The plan will be maintained until closure certification of the facility is provided to the DEQ Director. | 9 |
| (b) Content of plan. This section specifies requirements for the content of the closure plan:<br>(1) A description of how each hazardous waste management unit at the facility will be closed in accordance with § 265.111. | (1) This closure plan identifies steps necessary to close Tanks WM-184, WM-185, and WM-186, which is a partial closure of the TFF and INTEC. The general strategy is<br>▪ Isolate Tanks WM-184, WM-185, and WM-186 from the rest of the TFF by decontaminating valve boxes, pipe encasements, and vault sumps; isolating process lines and the vessel off-gas system<br>▪ Remove steam jet assemblies and radio frequency probes that will not be used during decontamination and corrosion coupons<br>▪ Wash tank walls and agitate tank heels using high-pressure water from a wash ball or similar high-pressure nozzle or nozzle arrangement simultaneously removing liquids and solids using remaining or newly installed steam jets<br>▪ Decontaminate the vault floor<br>▪ Sample and analyze tank residuals after decontamination to determine whether decontamination is complete or whether additional decontamination is required and is economical and practical<br>▪ Sample and analyze tank and vault residuals for comparison to action levels | 4.2, 4.3 |
| | ▪ Isolate non-process waste lines<br>▪ Perform final heel management and grout tank and components. | |

Table 3. (continued).

| 40 CFR, Part 265, Subpart G (2002)<br>Interim Status Treatment, Storage, and Disposal Facility Standards—Closure and Post-closure | | |
|---|---|---|
| Regulatory Requirement Summary | Compliance Strategy | Section in Plan |
| (2) A description of how final closure of the facility will be conducted in accordance with § 265.111, including the maximum extent of the operation, which will be unclosed during the active life of the facility. | Final closure of INTEC will be performed in accordance with approved interim status or HWMA/RCRA closure plans. A discussion of the maximum extent of operation unclosed is provided in Section 7. | 7 |
| (3) An estimate of the maximum inventory of hazardous wastes ever onsite over the active life of the facility and a detailed description of the methods to be used during partial and final closure, including waste removal methods. | The maximum inventory of hazardous waste ever in the tank system is discussed in this closure plan. Liquids and solids, including the tank heels, removed from Tanks WM-184, WM-185, and WM-186 will be transferred to another TFF tank for storage before treatment. | 1.3, 4.2 |
| (4) A detailed description of the steps needed to remove or decontaminate all hazardous waste residues and contaminated containment system components, equipment, structures, and soils. | Ancillary equipment will be triple-flushed with decontamination solution. The tanks will be flushed iteratively with decontamination solution, and residuals will be compared to action levels to ensure that clean closure criteria will be met.<br><br>Soil contamination is present at the TFF because of leaks from tank transfer piping. The contaminated soils will be investigated as part of the OU 3-14 RI/FS. The FFA/CO has established that investigations of Solid Waste Management Unit releases are the responsibility of the CERCLA program (IDHW, EPA, and DOE-ID 1991). | 3.3, 4.2, 5.2 |
| (5) A detailed description of other activities necessary during the partial and final closure period to ensure that all partial closures and final closure satisfy the closure performance standards. | No other closure activities have been identified at this time. | NA |

Table 3. (continued).

<table>
<tr><th colspan="3">40 CFR, Part 265, Subpart G (2002)<br>Interim Status Treatment, Storage, and Disposal Facility Standards—Closure and Post-closure</th></tr>
<tr><th>Regulatory Requirement Summary</th><th>Compliance Strategy</th><th>Section in Plan</th></tr>
<tr><td>(6) A schedule for closure of each hazardous waste management unit and for final closure of the facility.</td><td>Closure schedule (activities may run concurrently; the specific sequence in which tanks are closed may change, depending on logistics):
<table>
<tr><th>Activity</th><th>Time for Completion</th></tr>
<tr><td>Approval of partial closure plan and DOE Authorization to Proceed</td><td>Day 0</td></tr>
<tr><td>Remove waste and decontaminate WM-184</td><td>328 days</td></tr>
<tr><td>Evaluate results, grout and close WM-184</td><td>339 days</td></tr>
<tr><td>Remove waste and decontaminate WM-185</td><td>328 days</td></tr>
<tr><td>Evaluate results, grout and close WM-185</td><td>339 days</td></tr>
<tr><td>Remove waste and decontaminate WM-186</td><td>328 days</td></tr>
<tr><td>Evaluate results, grout and close WM-186</td><td>339 days</td></tr>
<tr><td>Submit professional 60-day engineer certification (time is in addition to the 2,001 days for closure)</td><td>60 days</td></tr>
</table>
NOTE: Waste removal, decontamination, and evaluation will commence on or before approval of the partial closure plan. Grouting will commence after DOE “Authorization to Proceed” is received.</td><td>8</td></tr>
<tr><td>(7) An estimate of the expected year of final closure for facilities without approved closure plans.</td><td>Use of the remaining tanks at the TFF must cease by December 31, 2012. The INTEC facility is estimated to be closed no sooner than 2035.</td><td>4.1</td></tr>
<tr><td>(8) This section applies to facilities where the Regional Administrator has applied alternative requirements at a regulated unit.</td><td>Not applicable.</td><td>N/A</td></tr>
</table>

Table 3. (continued).

| 40 CFR, Part 265, Subpart G (2002)<br>Interim Status Treatment, Storage, and Disposal Facility Standards—Closure and Post-closure | | |
|---|---|---|
| Regulatory Requirement Summary | Compliance Strategy | Section in Plan |
| (c) Amendment of plan. This section specifies requirements for amending the closure plan and includes conditions under which the closure plan must be amended, timeframes for providing the amendment, procedures for submitting the amended plan, and procedures for responding to a request for amendment by the regulatory agency. | The closure plan will be amended as necessary in accordance with the requirements of this section. | 9 |
| (d) Notification of partial closure and final closure. This section specifies when the closure plan must be submitted, the date when closure is expected to begin, and how opportunities for public comment on the closure plan will be provided. | Not applicable. | 8 |
| (e) Removal of wastes and decontamination or dismantling of equipment. Nothing in this section shall preclude the owner or operator from removing hazardous wastes and decontaminating or dismantling equipment in accordance with the approved partial or final closure plan at any time before or after notification of partial or final closure. | Closure activities will be performed in accordance with this closure plan. | NA |

Table 3. (continued).

| 40 CFR, Part 265, Subpart G (2002)<br>Interim Status Treatment, Storage, and Disposal Facility Standards—Closure and Post-closure | | |
|---|---|---|
| Regulatory Requirement Summary | Compliance Strategy | Section in Plan |
| § 265.113 Closure; Time Allowed for Closure | | |
| (a) This section specifies when closure activities must begin. The Regional Administrator may approve a longer period under certain conditions, including demonstration that closure activities will, of necessity, take longer than 90 days to complete, and demonstration that all steps have been taken and will continue to be taken to prevent threats to human health and the environment, including compliance with all applicable interim status requirements. | DOE is requesting an extension to the 90-day waste removal period. An extension is required because waste removal activities will, of necessity, require longer than 90 days. Complicating factors include<br>▪ The highly radioactive wastes stored in the tanks will require that much of the sampling and waste removal work be performed using remote handling technology, which will require significant lead times to set up and conduct<br>▪ The approach for partial closure of TFF tanks in sequence will require the continued availability of storage space in other tanks and treatment capacity in INTEC waste treatment systems for the wastes generated; operational problems in these systems could result in delays in the closure process<br>▪ Closure to action levels will involve an iterative process of decontamination, sampling, analysis, data review, and possibly, additional decontamination.<br>Tanks WM-184, WM-185, and WM-186 are to be closed because high radiation fields would make compliance with secondary containment requirements difficult and a need for such storage is not evident after 2012; however, all steps have been taken and will continue to be taken to prevent threats to human health and the environment. | 8 |

Table 3. (continued).

| 40 CFR, Part 265, Subpart G (2002)<br>Interim Status Treatment, Storage, and Disposal Facility Standards—Closure and Post-closure | | |
|---|---|---|
| Regulatory Requirement Summary | Compliance Strategy | Section in Plan |
| (b) This section specifies when partial and final closure activities must be completed. The Regional Administrator may approve a longer period under certain conditions, including demonstration that partial or final closure activities will, of necessity, take longer than 180 days to complete, and demonstration that all steps have been taken and will continue to be taken to prevent threats to human health and the environment from the unclosed but not operating hazardous waste management unit or facility, including compliance with all applicable interim status requirements. | DOE is requesting an extension to the 180-day closure period to 2,001 days. An extension is required because closure activities will, of necessity, require longer than 180 days. Complicating factors include<br>▪ The highly radioactive wastes stored in the tanks will require that much of the sampling and waste removal work be performed using remote handling technology, which will require significant lead times to set up and conduct.<br>▪ The approach for partial closure of TFF tanks in sequence will require the continued availability of storage space in other tanks and treatment capacity in INTEC waste treatment systems for the wastes generated; operational problems in these systems could result in delays in the closure process.<br>▪ Closure to action levels will involve an iterative process of decontamination, sampling, analysis, data review, and possibly, additional decontamination.<br>Tanks WM-184, WM-185, and WM-186 are to be closed because high radiation fields would make compliance with secondary containment requirements difficult and a need for such storage is not evident after 2012. However, all steps have been taken and will continue to be taken to prevent threats to human health and the environment. | 8 |
| (c) This section specifies when demonstration of conditions requiring an extension must be made. | The demonstrations necessary for extension of the closure periods requested are being submitted in this closure plan. | 8 |
| (d) This section specifies when the Regional Administrator may allow an owner or operator to receive non-hazardous wastes in a landfill, land treatment, or surface impoundment. | Not applicable. | N/A |
| (e) This section imposes additional requirements on the owner or operator of a hazardous waste surface impoundment that is not in compliance with the liner and leachate collection system requirements. | Not applicable. | N/A |

Table 3. (continued).

| 40 CFR, Part 265, Subpart G (2002)<br>Interim Status Treatment, Storage, and Disposal Facility Standards—Closure and Post-closure | | |
|---|---|---|
| Regulatory Requirement Summary | Compliance Strategy | Section in Plan |
| § 265.114 Disposal or Decontamination of Equipment, Structures, and Soils | | |
| During the partial and final closure periods, all contaminated equipment, structures, and soil must be properly disposed of or decontaminated unless specified otherwise in 40 CFR 265.197, 265.228, 265.258, 265.280, or 265.310. By removing all hazardous wastes or hazardous constituents during partial and final closure, the owner or operator may become a generator of hazardous waste and must handle that hazardous waste in accordance with all applicable requirements of 40 CFR 262. | All contaminated equipment, structures, and soils generated during closure of the tank system will be characterized, stored, and treated in accordance with applicable IDAPA 58.01.05.006 (40 CFR 262) requirements. | 6 |
| § 265.115 Certification of Closure | | |
| This section specifies the schedule and procedure for submitting the closure certification. The certification must be signed by the owner or operator and by an independent registered professional engineer. | Within 60 days of completing closure of the tank system, a certification that the tank system was closed in accordance with the specified activities and closure performance standards of the approved closure plan will be submitted to the DEQ Director. | 10 |
| § 265.197 Closure and Post-closure Care | | |
| (a) At closure of a tank system, the owner or operator must remove or decontaminate all waste residues, contaminated containment system components (liners, etc.), contaminated soils, and structures and equipment contaminated with waste, and manage them as hazardous waste. In addition, the requirements of 40 CFR Part 265 Subpart G (Closure and Post-Closure) and Subpart H (Financial Requirements) must be met. | The closure strategy developed for the tank system will meet this regulatory requirement. Subpart G requirements are discussed in detail earlier in this matrix. Pursuant to Section 265.140(c), the federal government, as owner of Tanks WM-184, WM-185, and WM-186, is exempt from Subpart H requirements.<br><br>Soil contamination is present at the TFF because of leaks from ancillary equipment, but contents never leaked to the environment from the tanks. The contaminated soils will be investigated as part of the OU 3-14 RI/FS. The FFA/CO has established that investigations of Solid Waste Management Unit releases are the responsibility of the CERCLA program. | 4, 11 |

Table 3. (continued).

| 40 CFR, Part 265, Subpart G (2002)<br>Interim Status Treatment, Storage, and Disposal Facility Standards—Closure and Post-closure | | |
|---|---|---|
| Regulatory Requirement Summary | Compliance Strategy | Section in Plan |
| (b) This section specifies when closure and post-closure care must be performed in accordance with requirements for landfills. If the owner or operator demonstrates that not all contaminated soils can be practicably removed or decontaminated as required in Section 265.197(a) above, then the owner or operator must close the tank system and perform post-closure care in accordance with the closure and post-closure care requirements that apply to landfills (40 CFR 265.310). | This section applies to the closure of WM-184, WM-185, and WM-186. This requirement is addressed in the contingent landfill closure plan (DOE-ID 2003). | Contingent Landfill Closure Plan |
| (c) This section imposes additional requirements for a tank system that does not have secondary containment that meets the requirements of 40 CFR 265.193 ("Containment and Detection of Releases"), including the preparation of a contingent plan for complying with 40 CFR 265.197(b) above. | This section applies to the closure of WM-184, WM-185, and WM-186. This requirement is addressed in the contingent landfill closure plan (DOE-ID 2003). | Contingent Landfill Closure Plan |

Table 4. Clean closure action levels for Tanks WM-184, WM-185, and WM-186.

| Constituent of Concern (Inorganic) | Action Level (mg/L) | Constituent of Concern (Organic) | Action Level (mg/L) |
|---|---|---|---|
| Aluminum | 3.1E+03 | Acetone | 9.9E+02 |
| Antimony | 6.3E+01 | Benzene | 3.7E–01 |
| Arsenic | 4.2E–01 | Bromomethane | 1.2E+02 |
| Barium | 8.3E+01 | Carbon disulfide | 9.9E+02 |
| Beryllium | 5.3E+00 | Carbon tetrachloride | 2.9E–01 |
| Cadmium | 6.1E–01 | Chloroethane | 9.6E+00 |
| Chromium | 9.0E–01 | Chloromethane | 4.5E+00 |
| Cobalt | 7.7E+02 | Cyclohexane | 7.5E+03 |
| Copper | 6.0E+02 | Cyclohexanone | 7.0E+03 |
| Fluoride | 7.7E+02 | 2,4-dinitrophenol | 1.4E+02 |
| Iron | 1.7E+03 | Ethyl acetate | 3.0E+03 |
| Lead | 4.0E+00 | Ethyl benzene | 9.9E+02 |
| Manganese | 4.9E+02 | 2-hexanone | 6.3E+02 |
| Mercury | 1.6E–01 | Methanol | 2.2E+03 |
| Nickel | 4.4E+02 | Methylene chloride | 6.0E+00 |
| Selenium | 8.9E–02 | Methyl ethyl ketone | 1.6E+02 |
| Silver | 3.0E+00 | Methyl isobutyl ketone | 8.9E+02 |
| Thallium | 2.6E+01 | N-nitrosodimethylamine | 7.3E–02 |
| Vanadium | 2.6E+02 | Phenol | 2.4E+03 |
| Zinc | 1.7E+03 | Polychlorinated biphenyl (Aroclor 1260) | 3.7E–01 |
| | | Pyridine | 4.3E+00 |
| | | Tetrachloroethylene | 4.5E–01 |
| | | Toluene | 1.4E+03 |
| | | 1,1,1-trichloroethane | 4.4E+02 |
| | | Trichloroethylene | 4.1E–01 |
| | | Xylene | 4.4E+03 |

# 4. CLOSURE STRATEGY

The decontamination activities in Tank WM-182 have been completed, including the sample collection and analysis of the verification samples required in the sampling and analysis plan (Portage Environmental 2002). Because that cleaning appears to be successful, the same closure strategy will be used for Tanks WM-184, WM-185, and WM-186. The closure strategy is designed to meet the clean closure requirements described in Section 3. The waste will be removed from the tanks, piping, and vaults. The tanks, vaults, and piping will then be decontaminated. Following decontamination, sampling and analysis will be performed, followed by data validation, data evaluation, and comparison to action levels. Closure activities for these tanks may run concurrently. Grouting of the tank, tank vault, valve box vaults, and piping can occur when the data indicate that hazardous waste is not left in place and concentrations of hazardous constituents are below action levels and are not RCRA hazardous.

As required by 40 CFR 265.111, “Closure Performance Standard” (2002), decontamination of the tanks and ancillary equipment, and grouting of the tanks, vaults, and piping will minimize post-closure escape of hazardous constituents by stabilizing the residuals in a solid matrix. Furthermore, process piping will also be capped (thus sealing any residues in the pipes) to minimize escape of hazardous constituents. The tank vaults will be decontaminated during decontamination of the pipe encasement, and samples from the vault sumps will be collected.

Closure activities include decontamination and removal of waste and residues, sampling and analysis of residuals, comparison to action levels, and grouting. The simplified closure sequence is shown in Figure 6. During closure, an independently registered Idaho professional engineer (PE) will review activities, data, closure methodologies, and waste management practices.

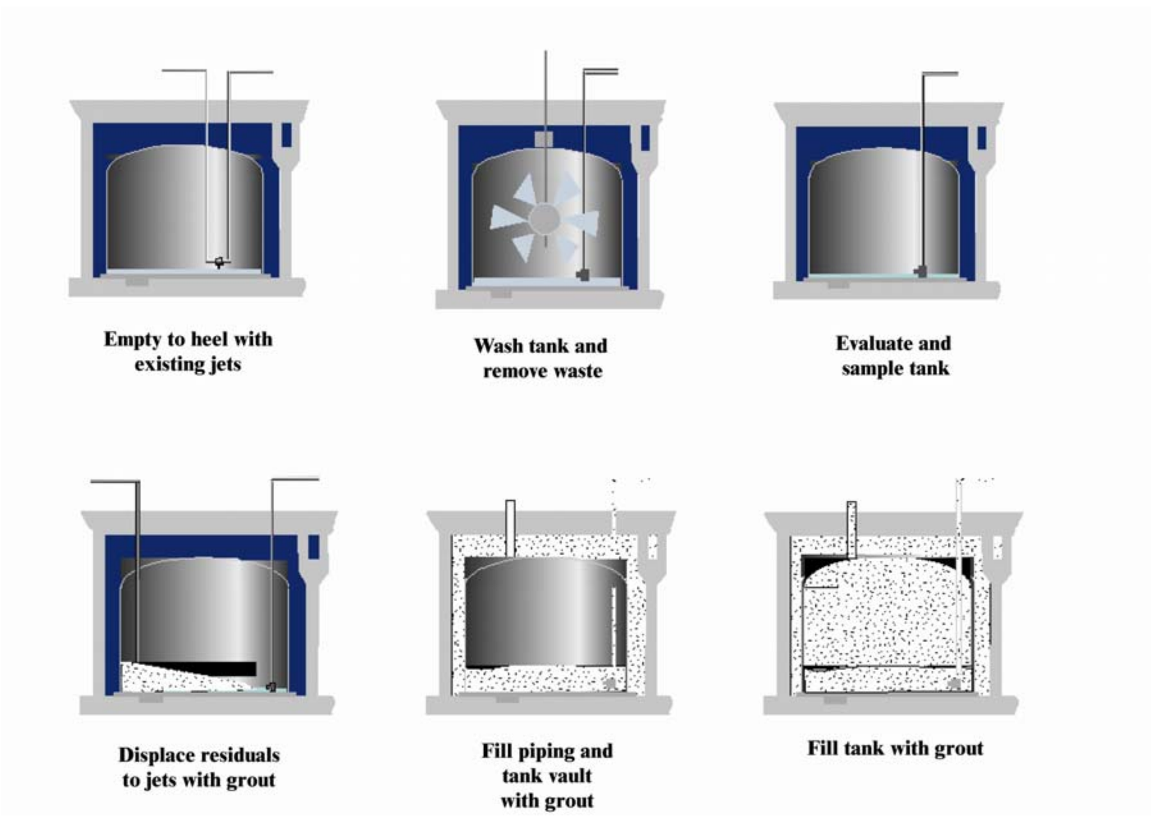



Figure 6. Simplified closure sequence.

The second modification to the Consent Order (IDHW 1998) specifies that DOE must cease use of pillar and panel tanks, including WM-184, WM-185, and WM-186, by June 30, 2003, and must cease use of the remaining tanks by December 31, 2012. Ceasing use of the tanks is defined as “emptying the tanks to their heels, i.e. the liquid level remaining in each will be lowered to the greatest extent possible by the use of existing transfer equipment” (IDHW 1998). Cease-use activities are the final stage of operations and precede the closure activities specified in this plan.

Waste removal under closure will begin when additional water is added (flushing water) then removed in conjunction with full-scale decontamination. New steam jets are planned to be installed and lowered to within approximately 1.0 in. of the tank floor to enhance waste removal. This level is much lower than that of the original steam jets. The remaining residual will be decontaminated by spraying high-pressure water to clean the tank walls, agitate the heel, and pump the resulting liquid and solid (to await further treatment) to another tank. Grout placement, which is not a part of the residual removal process, is being done to stabilize residuals and remove any remaining free liquids. The grouting will minimize the escape of any remaining residual contamination as described above.

The remainder of this section identifies the closure unit boundaries, the closure strategy, and the closure demonstration, including the methods and equipment to be used to decontaminate hazardous waste residues, contaminated containment system components, and contaminated structures and equipment for closure of Tanks WM-184, WM-185, and WM-186.

## 4.1 Facility Closure

IDAPA 58.01.05.009 and 40 CFR 265.112(b)(7) (2002) state that an estimate of the expected year of final closure for facilities without approved closure plans should be provided. The HWMA/RCRA facility is the TFF, which must cease use of the remaining tanks by December 31, 2012. The INTEC is a facility that has a future use projection “…that in 50 years the INTEC would be approaching the end of useful life if no new mission is identified” (DOE-ID 1995). It is estimated that the INTEC facilities will be closed no sooner than 2035. The following paragraphs provide a description of the closure unit boundaries.

Closure of Tanks WM-184, WM-185, and WM-186 constitutes a partial closure of the TFF. Tanks WM-182 and WM-183 have been decontaminated and will no longer be in operation. The remainder of the TFF tanks will continue to operate during the closure actions. Because Tanks WM-184, WM-185, and WM-186 may share associated piping and ancillary equipment with other tanks in the TFF, the definition of the tanks and related components or, more specifically, the tank systems being closed, is necessary.

For the purposes of this closure, the WM-184 tank system comprises Tank WM-184 (VES-WM-184), Vault CPP-784, and ancillary equipment such as piping, pumps, valve boxes, and associated Tank WM-184 piping and valves within the TFF Control House (CPP-628). Piping will be cut and capped upstream of the CPP-784 vault; valves will be isolated. Other ancillary equipment termination points included in the WM-184 tank system closure are the condenser pit (CPP-723), piping to Valve Box A7 (DVB-WM-PL-A7), and Valve Box C16 (DVB-WM-PL-C16). Figure 7 shows the WM-184 tank system to be decontaminated for closure. Figure 8 shows ancillary equipment that will be taken out of service during closure but will not require decontamination because it has not contacted hazardous waste. Examples of ancillary equipment that did not contact hazardous waste include equipment installed but never used, the supplied air or steam supply to the tank system, and the equipment used for instrumentation connections.

For the purposes of this closure, the WM-185 tank system comprises Tank WM-185 (VES-WM-185), Vault CPP-785, and ancillary equipment such as piping, pumps, valve boxes, and associated Tank WM-185 piping and valves within the TFF Control House (CPP-628). Piping will be cut and capped upstream of the CPP-785 vault; valves will be isolated. Valve Box C14 (DVB-WM-PL-C14) is included in the WM-185 tank system closure. Condenser Pit CPP-722 will be decontaminated and grouted. Figure 9 shows the WM-185 tank system to be decontaminated for closure. Figure 10 shows ancillary equipment that will be taken out of service during closure but will not require decontamination because it has not contacted hazardous waste. Examples of ancillary equipment that did not contact hazardous waste include equipment installed but never used, the supplied air or steam supply to the tank system, and the equipment used for instrumentation connections.

For the purposes of this closure, the WM-186 tank system comprises Tank WM-186 (VES-WM-186), Vault CPP-786, and ancillary equipment such as piping, pumps, valve boxes, Condenser Pit CP1, and associated Tank WM-186 piping and valves within the TFF Control House (CPP-628). Piping will be cut and capped upstream of the CPP-786 vault; valves will be isolated. Another ancillary equipment termination point included in the WM-186 tank system closure is Valve Box C19 (DVB-WM-PL-C19). Figure 9 shows the WM-186 tank system to be decontaminated for closure. Figure 10 shows ancillary equipment that will be taken out of service during closure but will not require decontamination because it has not contacted hazardous waste. Examples of ancillary equipment that did not contact hazardous waste include equipment installed but never used, the supplied air or steam supply to the tank system, and the equipment used for instrumentation connections.

The TFF Control House (CPP-628) contains the steam, water, air, cooling, and instrumentation lines for Tanks WM-184, WM-185, and WM-186. This building also contains similar equipment for other TFF tanks, which will not be closed as a part of this closure plan. Piping and valves associated with Tanks WM-184, WM-185, and WM-186 will be capped in the TFF Control House. Appendix C contains a piping list for closure of Tanks WM-184, WM-185, and WM-186. Tables C-3, C-4, and C-5 show piping and conduit that do not require decontamination or closure.

The following line and equipment designators are used in Figures 7 through 10:

- CA and DCN—decontamination line
- DVB—diversion valve box
- HAS—high-pressure steam
- INST—instrumentation
- LAA—low-pressure air
- PLA, PUA, PWA—process waste lines
- SR—sump riser
- TR—tank riser
- WRA—cooling solution return line
- WSA—cooling solution supply line.

## 4.2 Closure

### 4.2.1 General Closure Activities

The high-pressure water from a wash ball (or similar high-pressure nozzle or nozzle arrangement to wash the tank walls and agitate the tank heels) will be used to remove waste and decontaminate the tank. The decontamination fluid for WM-184, WM-185, and WM-186 closure will be demineralized water. Water will be obtained from water sources near the TFF. Liquids and solids will be removed using the steam jets simultaneously with wall decontamination and heel agitation. The liquids and solids removed from Tanks WM-184, WM-185, and WM-186 will be stored in an existing TFF tank to await treatment. A video camera and lighting will be installed to monitor and record removal and decontamination efforts. For activities where hazardous constituent contamination may exist, confinement (e.g., temporary enclosures and high-efficiency particulate air [HEPA] filter structures) will be placed to minimize risk of contamination spread.

The ancillary equipment to the tanks consists of valve boxes, piping, trenches, and condenser pits. Table 5 provides an overview of the ancillary equipment and Appendix C lists the piping associated with the closure of WM-184, WM-185, and WM-186. Not all the ancillary equipment in the following description will be closed (decontaminated and grouted) during this phase of closure. Some equipment has never contacted hazardous waste, while other equipment is not scheduled to be closed during this phase of closure. For example, the instrumentation conduit shown in Figures 8 and 10 contains wiring and has been sealed at both ends to prevent entry of hazardous constituents. Ancillary equipment needed for operating tanks cannot be closed.

TFF tank systems WM-184, WM-185, and WM-186 use numerous piping routes to transfer waste solutions, vessel off-gas, and high-pressure steam to and from each tank. Valves housed in diversion valve boxes (DVBs) or condenser pits are used to manipulate all piping transfer routes to and from the TFF tanks. Valve boxes directly associated with Tanks WM-184, WM-185, and WM-186 closure are listed in Table 5. The descriptions of the valve boxes below are included to list piping associated with each valve box. Only the piping and valve boxes shown in green on Figures 7 and 9 and listed in Appendix C are to be closed during this phase of the TFF closure.

### 4.2.2 Tank Isolation and Decontamination of Ancillary Systems

The following discussion outlines the sequence of activities required to isolate Tanks WM-184, WM-185, and WM-186 from the rest of the TFF to allow closure activities to take place. The remainder of this section also describes the decontamination of ancillary systems associated with Tanks WM-184, WM-185, and WM-186. The decontamination of ancillary systems is generally sequenced based on a logical progression that ensures decontaminated areas will not be re-contaminated by subsequent operations. Generally, the sequence of activities is

- Valve box decontamination
- Process waste line decontamination and isolation
- Pipe encasement decontamination
- Vault decontamination
- Removal of system components and installation of cleaning equipment

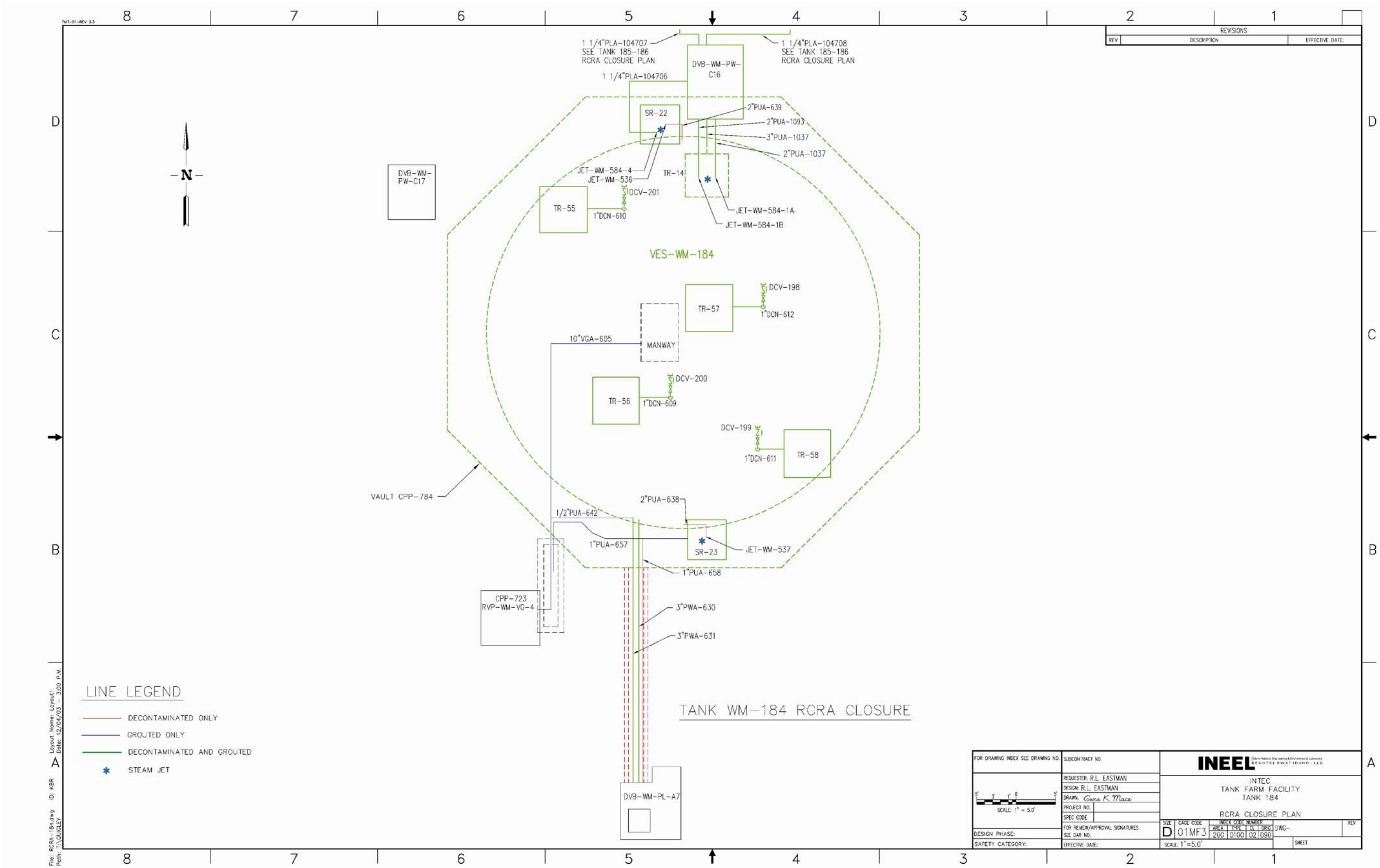



Figure 7. Tank WM-184 systems to be decontaminated during closure.

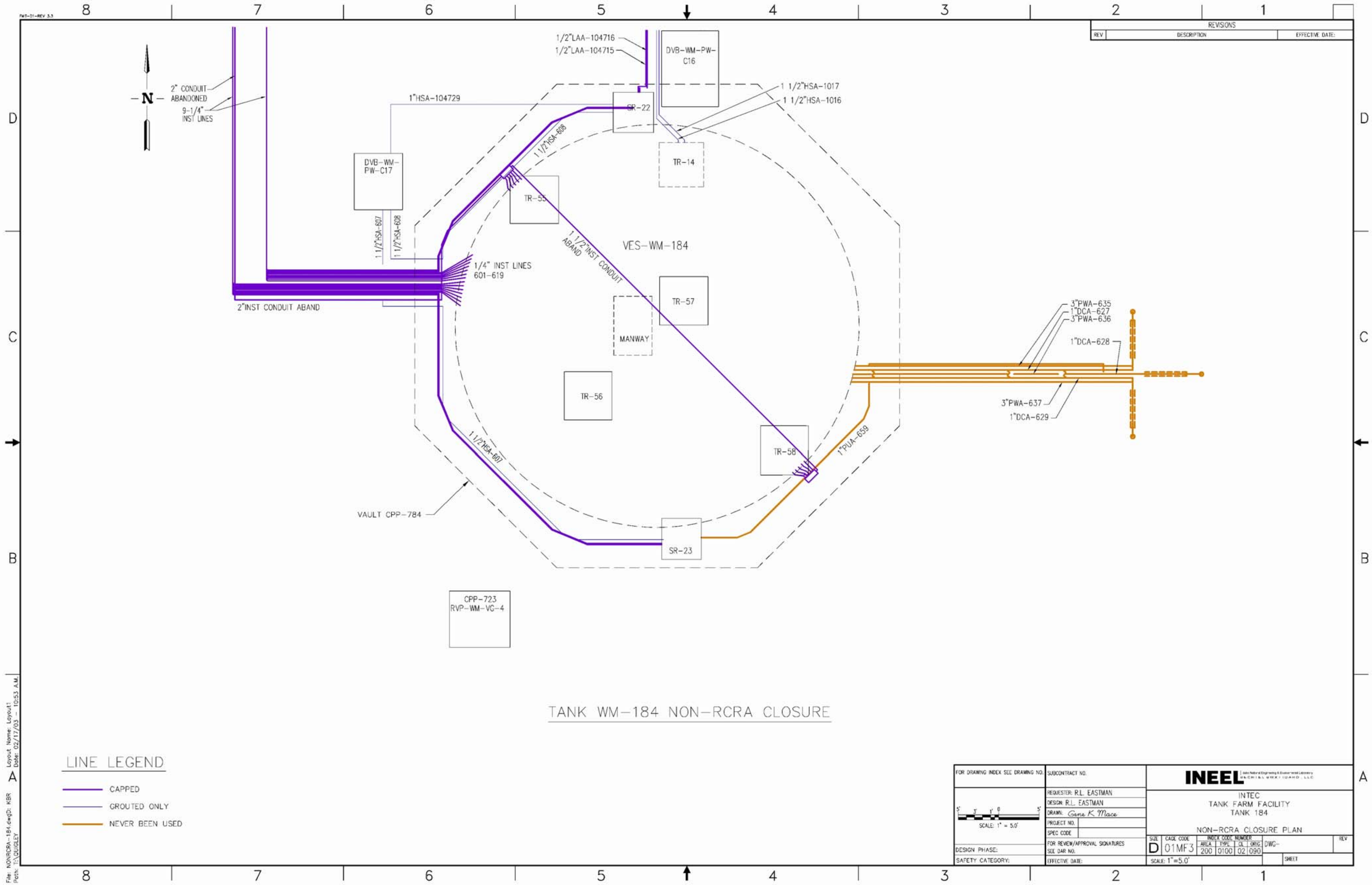



Figure 8. Tank WM-184 systems that do not require decontamination.

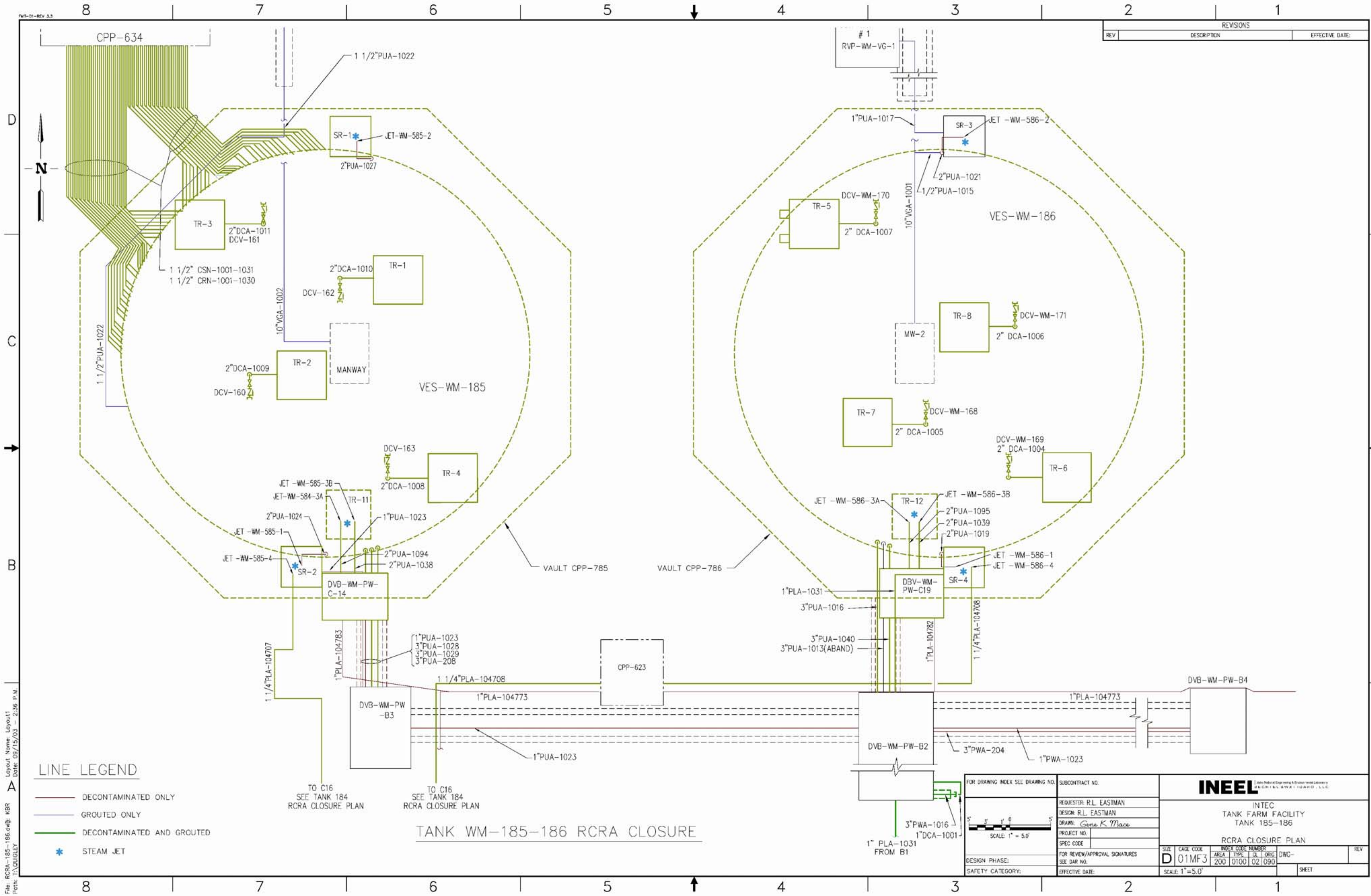



Figure 9. Tank WM-185 and WM-186 systems to be decontaminated during closure.

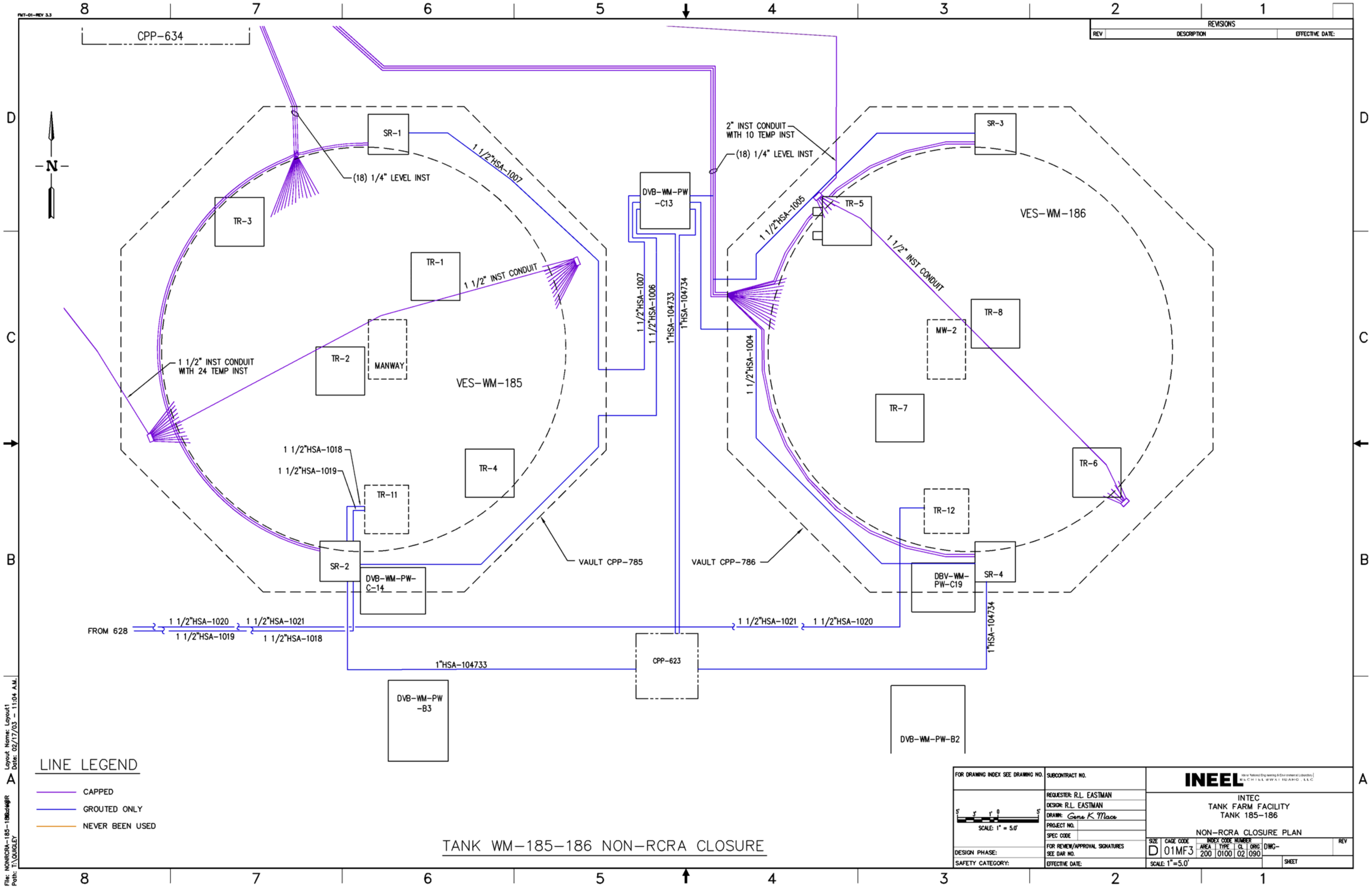



Figure 10. Tank WM-185 and WM-186 systems that do not require decontamination.

Table 5. Equipment associated with WM-184, WM-185, and WM-186.

| Ancillary Equipment | Description | Comments |
|---|---|---|
| SR-1 | North vault sump riser for WM-185 | Jet WM-585-2 |
| SR-2 | South vault sump riser for WM-185 | Jets WM-585-1 and WM-585-4 |
| SR-3 | North vault sump riser for WM-186 | Jet WM-586-2 |
| SR-4 | South vault sump riser for WM-186 | Jets WM-586-1 and WM-586-4 |
| SR-22 | North vault sump riser for WM-184 | Jets WM-584-4 and WM-536 |
| SR-23 | South vault sump riser for WM-184 | Jet WM-537 |
| TR-1 | Tank riser for WM-185 | |
| TR-2 | Tank riser for WM-185 | |
| TR-3 | Tank riser for WM-185 | |
| TR-4 | Tank riser for WM-185 | |
| TR-5 | Tank riser for WM-186 | |
| TR-6 | Tank riser for WM-186 | |
| TR-7 | Tank riser for WM-186 | |
| TR-8 | Tank riser for WM-186 | |
| TR-55 | Tank riser for WM-184 | |
| TR-56 | Tank riser for WM-184 | |
| TR-57 | Tank riser for WM-184 | |
| TR-58 | Tank riser for WM-184 | |
| DVB-WM-PW-C14 | Valve box for WM-185 waste transfer lines | |
| DVB-WM-PW-C16 | Valve box for WM-184 waste transfer lines | |
| DVB-WM-PW-C19 | Valve box for WM-186 | |
| CP-1 | Control pit for WM-186 | |
| CPP-623 | | Steam to vault sumps SR-2 and SR-4 |
| CPP-628[a] | TFF Control House | Control building for TFF instrumentation and transfer valves |
| CPP-634 | | Sample port building for WM-185 cooling coils |
| CPP-722 | Condenser pit for WM-185 | |
| CPP-723 | Ventilation pit for WM-184 | |

a. This building will not be closed during closure of WM-184, WM-185, and WM-186.

- Non-process waste line isolation
- Tank decontamination.

The activities have been segregated into stages based on construction logic. The decontamination sequence may change based on field conditions. These decontamination sequence changes would not jeopardize the closure performance standards, would be considered minor deviations, and would be noted by the independent PE during certification. Therefore, sequence changes would not require an amendment to the closure plan.

Cleaning operations will begin with the valve boxes and end with the steam jet lines required to remove decontamination fluids displaced during the initial grout placements in the waste tanks. This logical progression through lines and equipment ensures that cleaned areas will not be re-contaminated as cleaning operations continue within the closure boundaries. Figures 7 and 9 and Appendix C show the closure equipment and piping.

***4.2.2.1 Valve Box Decontamination.*** Isolation of Tanks WM-184, WM-185, and WM-186 will begin with decontamination of selected valve boxes. Decontamination equipment will be used in the valve boxes and connected to a water source. The inside surfaces of each valve box will be decontaminated. The decontamination fluids will be allowed to drain through existing drains in the valve boxes to the associated vault sumps, decontaminating the drain lines and vault, the vault sump, and vault floor. The existing steam jet pumps in each tank vault sump will be used to pump out the decontamination fluid. Samples of decontamination solution will be collected from the vault sumps after decontamination is complete.

The data obtained from final sampling will be included in the comparison to action levels. Samples of decontamination solution will be collected before grouting. The sample will be taken from one of the accessible sumps in each tank vault.

***4.2.2.2 Process Waste Line Decontamination and Isolation.*** Process waste lines to be closed will be isolated in valve boxes. Split-flow valve cartridges may be installed to replace various valves on process waste lines. This will enable grout to be placed in the lines leading to the tanks while allowing decontamination and subsequent grouting of lines leading to other portions of the TFF. Split-flow valve cartridges were designed to isolate pipelines without having to manually and/or remotely cut and remove pipe sections in contaminated areas. Use of these cartridges limits worker exposure and minimizes pipe cutting and welding in hazardous environments. A split-flow valve cartridge replaces the ball valve components with a separating plate.

Process waste lines will be triple rinsed with decontamination fluid, which will be drained to Tank WM-184, WM-185, WM-186, or the TFF system depending on which system is being decontaminated. Triple flushing with water has been successfully used to decontaminate piping in the TFF to remove residual waste from piping, reduce radiation fields, and limit the potential for airborne radioactivity. Historically, successful decontamination of the lines has been performed during maintenance and repair work on the systems (i.e., valve replacement or repair requiring welding of lines). During the work, lines were decontaminated. The process used water flushing through the lines from a decontamination connection inside the TFF Control House (CPP-628). When the lines were cut in preparation for welding and visually inspected, the lines were observed to be free of liquids and loose solids (Demmer 1996).

Since the piping systems of Tanks WM-184, WM 185, and WM-186 are very similar to Tanks WM-182 and WM-183, the analysis of samples from the piping in Tanks WM-182 and WM-183 is judged to be representative of piping lines in Tanks WM-184, WM-185, and WM-186. Therefore, no additional pipe samples will be collected.

***4.2.2.3 Pipe Encasement Decontamination.*** The stainless-steel-lined concrete encasements that provide secondary containment for process waste lines will be decontaminated. Each encasement will be triple rinsed with decontamination solution. The decontamination fluids will be allowed to drain through existing 1-in. drain lines to the south vault sumps to decontaminate the drain lines. Once decontamination is complete, samples will be taken from tank vault sumps to ensure action levels are met. Decontamination fluids that accumulated in the sumps of each vault will be transferred using existing steam jets to the PEW evaporator after samples have been collected.

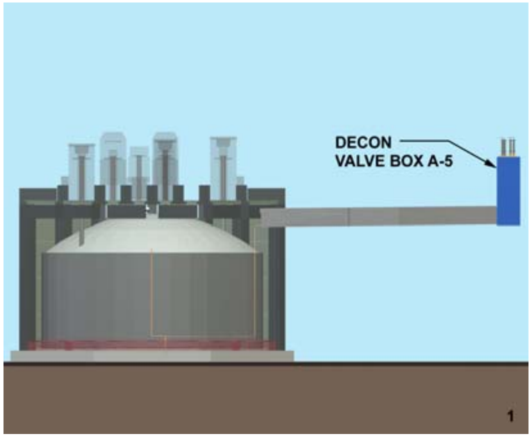
The pipe encasement decontamination also will allow for decontamination of the tank vault floor. Historically, the only way that waste may have entered the vaults associated with Tanks WM-184 and WM-186 is from valve or pipe leaks, which were collected in the encasements that drain to the vault sump. The volume of liquid released to the vault sump and, subsequently, to the vault floor was minimal. Tank WM-185 experienced a siphoning incident in 1962. Waste from the tank was siphoned into the vault sump through the sump jet discharge lines in the tank. Once detected, the waste was returned to the tank and remaining contamination was considered minimal.

Infiltration of water into the vaults from surrounding soils during spring runoff and significant precipitation events has covered the vault floor at times. This infiltrated water likely has served to help remove any waste discharged to the vaults from the pipe encasements. During closure, decontamination fluid will be introduced into the encasement and will flow into the vault sump and onto the vault floor, following the path by which waste may have previously entered the tank vault. The rinsing sequence will be performed three times with a sufficient volume of demineralized water to adequately cover the vault floor. Figure 11 shows the decontamination flow path. In this way, the flushes will decontaminate both the encasements and the vault floor. The decontamination fluid will be pumped out as described above and samples will be collected. Sampling will be indicative of the residual left in the vault, encasements, and valve boxes.

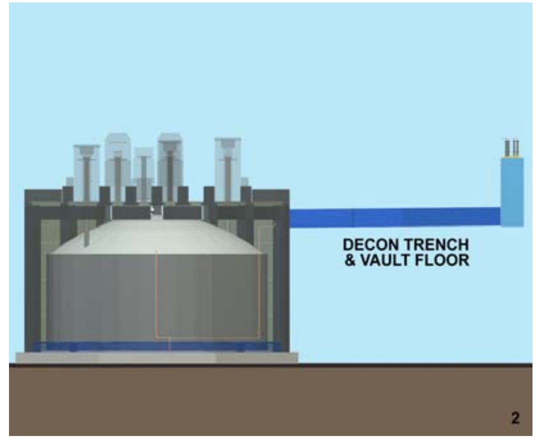
***4.2.2.4 Vault Decontamination.*** The decontamination fluid used to clean the pipe encasements and valve boxes will be allowed to flow into the vaults and to the vault sumps. Remaining liquids will be transferred using the steam jets to the PEW evaporator. This process will decontaminate the vaults, vault sumps, and waste line piping. Sampling of the vault sumps will provide sufficient data to characterize the vaults (the sumps are the lowest points within the vault). Following decontamination, samples will be collected from liquids remaining in the vault sumps. These sample results will be used in the evaluation of action levels. After the vault sumps are emptied and the vault liquid removal lines have been decontaminated, the steam jets and lines for the sumps can be disconnected.

Data from various locations, such as the tank vault sump and tanks, will be evaluated using statistical techniques. Several different statistical methods will be applied to the TFF closure data. There are two primary objectives with regard to the statistical analysis of the data. The first objective is to determine if the constituents of interest are present in levels greater than the specified action level. The second objective is to determine if the contents of the tanks and the vault sumps come from the same population. The description of the proposed statistical analysis is presented in Appendix D.

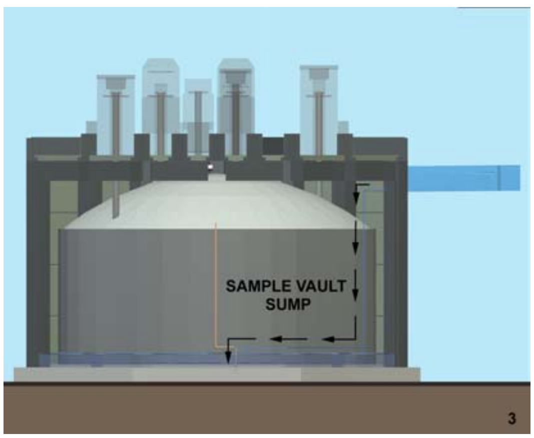
***4.2.2.5 Removal of System Components and Installation of Cleaning Equipment.*** After the covers are removed from the risers using standard INTEC procedures, steam and process waste lines inside the tank risers will be isolated. Liquid level indicators installed in the tanks and corrosion coupons installed in the tanks will be removed and managed in accordance with applicable regulations as discussed in Section 6.3. Steam jets will be left in the tank for use in the decontamination process.



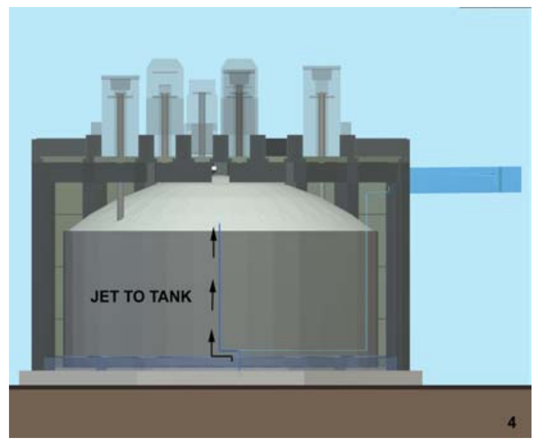

1. The valve box is decontaminated first.




2. Next, the piping trench and vault floor are decontaminated.




3. Samples of the decontamination rinse water are obtained from the vault sumps.




4. Vault steam jets pump the decontamination rinse water into the respective tank.

Figure 11. The valve box, piping trench, and vault floor decontamination flow path.

Tank washing and video surveillance systems will be installed in the tank risers. The remaining steam jets in Tanks WM-184, WM-185, and WM-186 or new steam jets at a lower position in the tank will be used to remove waste and decontaminate the tanks. The jets will not be removed, as discussed in the next section.

***4.2.2.6 Non-Process Waste Line Isolation***. The cooling coil lines for Tank WM-185 (sixty 1.5-in. lines) will be decontaminated using decontamination solution flushes. Tanks WM-184 and WM-186 do not have cooling coils. The decontamination solution from the cooling coils will be sampled and disposed of in accordance with applicable regulations. The 6-in. supply and return headers for the tank will be disconnected in the TFF Control House (CPP-628). The active supply and return lines for the cooling system will be temporarily capped. Following flushing, the supply headers for each tank will be connected to a compressed air supply and purged with air. After purging, the cooling coil lines will be disconnected at the headers and both ends will be temporarily capped. Tank instrumentation lines for

Tanks WM-184, WM-185, and WM-186 will be isolated from each line in the TFF Control House. Two 2-in. electrical conduits that carry 24 thermowell instrumentation lines to each tank will be cut inside the TFF Control House. The portions of these conduits inside the building will be disposed of appropriately, and the portions leading to the tanks will be permanently capped.

***4.2.2.7 Tank Decontamination.*** The existing steam jets are 12 in. off the bottom of the tank. Therefore, new steam jets are planned to be installed and lowered to within approximately 1.0 in. of the tank floor to enhance waste removal. The steam jets will be used to pump out as much of the tank heels as possible. The washing system described in the *Conceptual Design Report, INTEC Tank Farm Facility Closure* (INEEL 2000a) will agitate the heels to allow more effective waste removal. The solids will be suspended in liquid by the agitation as demonstrated by the decontamination of Tanks WM-182 and WM-183. Engineering studies prepared for the Conceptual Design Report have indicated the steam jets will effectively remove the tank heel. The steam jets will not be removed at the end of decontamination but will be effectively decontaminated by removing thousands of gallons of decontamination fluid from the tank. If the tank liquid meets specified action levels, it will be concluded that the steam jet will also be decontaminated. The tank heel will be sent to another existing tank within the TFF. The tank washing and video systems will be activated to wash the tank walls. The steam jets will be operated during washing to remove waste residues. Video systems will be used to evaluate and record the effectiveness of the tank wall decontamination. The sampling and analysis approach is described in detail in the *Sampling and Analysis Plan for the Post-Decontamination Characterization of the WM-184, WM-185, and WM-186 Tank Residuals* (Portage Environmental 2003).

The initial tank washing sequence is designed to remove contaminants and provide incidental pH adjustment of the heels. The final pH in the decontaminated tank residuals will be confirmed to be greater than 2.0 but less than 12.5.

After decontamination, the tank residuals will be sampled to determine their final composition. Samples will be obtained using a pump or other sampling device to be installed in a tank riser. These samples will be compared to action levels. During tank decontamination, a visual inspection by the remote camera will be used to ensure that the tank walls and floor are clean. Radiation detection instruments will be used to measure radiation levels in the waste and decontamination fluid as it is removed from the tanks. As the concentrations of radionuclides are reduced and stabilize, decontamination will cease.

The data collected from sampling the residuals will be used to determine if the decontamination was successful. Successful decontamination is defined as removing hazardous waste and meeting the criteria described in Section 2.1. If the data are conclusive regarding removal of hazardous waste, decontamination efforts will stop and the data will be compared to action levels to determine if clean closure has been achieved. If the concentration of contaminants exceeds the action levels, decontamination will continue until the process is no longer economical or practical. Landfill closure will be determined at final closure of the TFF.

### 4.2.3 Sampling of Tank Residuals and Ancillary Equipment

At the conclusion of decontamination activities, samples of tank residuals will be collected to determine the concentrations of hazardous constituents remaining in the tanks. During the tank washing, a radiation detection instrument will be used to measure radiation levels of waste removed from the tanks. When the concentrations of radionuclides are reduced and begin to stabilize, the effectiveness of further decontamination will be minimal. At that point, decontamination will cease. The correlation of removal efficiency between radionuclides and metals in the tank will be sufficient to determine when decontamination efficiency has been maximized indicating that sampling for comparison to action levels may begin. Samples of the residual will be collected to confirm that decontamination has occurred.

The samples will be analyzed for hazardous constituents and radionuclides in accordance with DOE closure plans. The sample data will be used to determine if clean closure objectives have been reached. The sample data for hazardous constituents will be compared to the action levels. If the action levels have not been reached, decontamination may resume if it is determined further efforts are likely to be successful. The sampling and analysis approach is described in detail in the *Sampling and Analysis Plan for the Post-Decontamination Characterization of the WM-184, WM-185, and WM-186 Tank Residuals* (Portage Environmental 2003).

These samples are described in the sampling plan referenced above. All sample data from the tanks and ancillary equipment will be examined to determine if they are from the same population. The statistical analysis to determine if the data are from the same population is included in Appendix D. The 95% upper confidence level around the mean of each population will be used to compare to the contaminant specific action level. Action levels are shown in Table 4 and the methodology for calculation is explained in Appendix B.

## 4.3 Grouting Activities

After tank isolation activities are completed, a determination has been made regarding the effectiveness of decontamination, and decisions for DOE closure and HWMA closure have been made, final heel management and tank grouting will begin. At that time, the tank vaults will be isolated and final grouting of the tank system, including the vaults, will be performed. The decision for landfill closure will be determined based on results from all tanks in the TFF. Physical access to some areas does not allow for piping to be grouted. Figures 7 through 10 show the pipes that will only be decontaminated or capped.

### 4.3.1 Final Heel Management and Initial Tank Grouting

Grout delivery equipment will be installed through tank risers on Tanks WM-184, WM-185, and WM-186. Video surveillance equipment also will be installed through risers on the tanks. Grout will be placed in each tank in layers following a predetermined sequence. The first grout layer will be placed in a manner that displaces as much of the remaining tank residuals as possible and moves remaining residual toward the steam jet for removal from the tank. As the grout is placed, the remaining tank residual (liquid and solid) will be pumped (using the steam jets remaining in each tank) and transferred through process waste piping to storage in another TFF tank to await further treatment. After the initial grout placements to remove residuals, the tank will be leveled with grout to approximately 4 ft.

Steam supply lines (1.5-in.) will be cut. The steam lines will then be permanently capped. Dry grout or another absorbent may be placed in the tanks if free liquids remain. Video inspection will be used to determine if free liquids remain and if additional absorbent is necessary.

### 4.3.2 Final Grouting

The final grouting will include grouting the pipe encasements. Grout will be pumped through the encasement covers and valve boxes. This process will grout over the 1-in. encasement drain lines. Vault instrumentation lines will be filled with grout by removing the temporary caps installed in the TFF Control House. The lines will then be permanently capped.

Vaults will be filled with grout from the vault risers. The grout will be placed in lifts. After the vaults have been filled, the vault risers will be filled to the bottoms of the vault riser lids.

The cooling coil lines for each tank will be grouted by connecting the grouting equipment to the cooling coil headers. Grout will be pumped into each line until it comes out of the return end or until the line no longer accepts grout. The supply and return ends of each cooling coil header will then be permanently capped. Process piping, as noted in Figures 7 through 10, will be grouted in a process similar to the cooling coils.

The large tank void remaining after the initial grout placements to remove residuals will be filled with grout. The grout will be placed in lifts until the tank is full. Video surveillance equipment and lighting will be installed in the center-most tank risers to observe grout placement. The grouting equipment will be reinstalled on the outermost tank risers.

Another grouting sequence will involve the vessel off-gas lines. The grouting equipment will be connected to the lines and grout will be pumped through these lines until grout enters the tank risers. This action will also grout the ends of the PEW lines that connected the two tanks. After the remaining tank voids and the vessel off-gas lines are filled with grout, the lines will be permanently capped.

Any remaining voids in the tank risers will be filled with grout. The tank riser access boxes will be filled with grout and the tank riser access box covers will be reinstalled.

Grouting completion also concludes the closure process for Tanks WM-184, WM-185, and WM-186. The closure process will be documented and certified as described in Section 10, and closure-generated wastes will be disposed of as described in Section 6.

# 5. COORDINATION WITH OTHER REGULATORY REQUIREMENTS

As an interim status hazardous waste management unit, the TFF must comply with applicable HWMA/RCRA regulations. However, the TFF is also a HLW facility regulated by DOE and must meet DOE closure requirements. In addition, other ongoing INTEC and TFF actions may also affect the TFF HWMA/RCRA closure activities. These actions include the CERCLA cleanup of the TFF soils and decisions made pursuant to the *Idaho High-Level Waste and Facilities Disposition Final Environmental Impact Statement* (DOE 2002). Therefore, this HWMA/RCRA closure will be carefully coordinated with each of these other requirements to ensure that the objectives of all activities at the TFF are met efficiently and economically.

## 5.1 DOE Radioactive Waste Management Requirements

Because the TFF is an HLW facility regulated by DOE, this closure must meet the requirements of DOE Order 435.1 (DOE 2001a) and its associated manual and guidance (DOE 2001b; DOE 1999a). Closure requirements for HLW facilities are specified in DOE Manual 435.1-1 (DOE 2001b). The TFF will be closed under an approved DOE closure plan (DOE 2002), in accordance with DOE Order 435.1.

DOE requires a two-tiered approach to closure plan development, review, and approval. The Tier 1 Closure Plan, approved by DOE Headquarters, was based on preliminary information and is intended to define and bound the parameters of the closure action. The first-tier plan includes

- Closure methodology
- Schedules and assumptions
- Closure standards and performance objectives (for the radioactive constituents)
- Strategy for allocating closure standards and performance objectives to individual facilities and units to be closed at the site
- Preliminary assessment of the projected performance of each unit to be closed relative to the allocated performance objectives
- Preliminary assessment of the projected composite performance of all units to be closed at the site
- Alternatives (if any)
- Waste characterization data
- Closure controls plans
- Stakeholder concerns.

The DOE Tier 1 Closure Plan (DOE-ID 2003) has been prepared and is being reviewed. Once DOE Headquarters approves the plan, they will issue an Authorization to Proceed. Cleaning of the tanks can proceed before DOE Headquarters approval. Once the cleaning of WM-184, WM-185, and WM-186 is complete, a Tier 2 plan will be prepared to discuss the readiness to proceed with final closure (grouting) activities.

## 5.2 Comprehensive Environmental Response, Compensation, and Liability Act Requirements

In November 1989, the INEEL was listed on the National Priorities List (54 Federal Register [FR] 223, 1989). In 1991, the FFA/CO was written to establish a framework for fulfilling both CERCLA remedial action and RCRA corrective action requirements (IDHW, EPA, and DOE 1991). The FFA/CO divides the INEEL into ten waste area groups (WAGs) which are further divided into OUs. INTEC is designated as WAG 3 with 14 OUs (IDHW, EPA, and DOE 1991).

For closure of tank systems, HWMA/RCRA requires investigation of associated contaminated soils. Past leaks from TFF transfer piping have contaminated areas of the TFF soils. The OU 3-13 Final Record of Decision (DOE-ID 1999) states that investigation of the hazardous constituents in the TFF soils will be addressed during the OU 3-14 RI/FS (DOE-ID 2000a). Therefore, remediation of these soils will be addressed by the CERCLA OU 3-14 ROD and will address the RCRA closure requirements within the regulatory framework and authority of the FFA/CO as a RCRA Corrective Action. Table 4 identifies constituents of concern that are reasonably expected in the soils. A summary of information regarding TFF soils from investigation/remediation activities available at the time of final TFF closure will be included in the PE certification documentation.

## 5.3 High-Level Waste and Facilities Disposition Environmental Impact Statement Requirements

Closure of the TFF and Tanks WM-184, WM-185, and WM-186 also may be affected by the decisions made on the basis of the *Idaho High-Level Waste and Facilities Disposition Final Environmental Impact Statement* (DOE 2002). This document addresses three primary decision-making goals:

- How to treat sodium-bearing waste
- How to treat HLW calcine into final waste form ready to leave the State of Idaho by December 2035
- How to conduct the disposition of associated HLW program facilities, including the TFF.

The three environmental impact statement general closure alternatives are

- Clean closure
- Closure to landfill standards
- Performance-based closure.

The environmental impact statement was prepared to fulfill commitments DOE made as part of the terms of a 1995 settlement agreement and court order with the State of Idaho (State of Idaho, DOE, and Department of Navy 1995). Under the agreement and court order, DOE must cease use of the TFF tanks by 2012 and treat all HLW currently at the INEEL so that the waste is ready for removal from the State of Idaho by 2035. To meet this requirement, DOE must issue a record of decision no later than December 31, 2009, based on an environmental impact statement that analyzes alternatives for treating INEEL HLW. On September 19, 1997, DOE issued a "Notice of Intent to Prepare a High-Level Waste and Facilities Disposition Environmental Impact Statement, Idaho Falls, Idaho" (62 FR 182, 1997). The EIS was issued in September 2002 (DOE 2002).

Both DOE and the State of Idaho have designated a performance-based closure method as the preferred alternative for disposition of HLW facilities at INTEC. These methods encompass three of the six facility disposition alternatives analyzed in the EIS: clean closure, performance-based closure, and closure to landfill standards. These methods are consistent with the closure approach proposed for the TFF in this closure document. A DOE Record of Decision is expected in 2003.

# 6. CLOSURE-GENERATED WASTE HANDLING AND DISPOSAL

In accordance with IDAPA 58.01.05.006 (2002) (40 CFR 262.11 [2002]), all solid waste generated during the closure process for Tanks WM-184, WM-185, and WM-186 is required to be properly characterized to determine if the waste is a hazardous waste. If so, the waste must be managed as a hazardous waste in accordance with all applicable HWMA/RCRA regulations. Circumstances may arise during closure implementation that requires removal of equipment and treatment for reuse or disposal rather than leaving the equipment in place as planned. Conversely, leaving some equipment in place may be necessary or desirable to limit personnel radiation exposure.

As stated in more detail in Section 1.2, wastes stored in Tanks WM-184, WM-185, and WM-186 exhibit the hazardous characteristics of corrosivity (hazardous waste number D002) and the characteristic of toxicity for lead (D008) and mercury (D009), cadmium (D006), and chromium (D007). Also associated with the waste are four RCRA listed waste codes: F001, F002, F005, and U134 (Gilbert and Venneman 1999).

## 6.1 Decontamination and Treatment of Equipment for Disposal

Contaminated equipment from Tanks WM-184, WM-185, and WM-186 closure activities will be decontaminated or treated for all hazardous constituents present, as indicated by the baseline sampling results and the historical inventory of wastes managed in the tanks. Treatment will consist of subjecting the equipment to one or more existing treatment technologies identified in IDAPA 58.01.05.011 (2002) (40 CFR 268.45, 2002). The specific technology or technologies will be selected at the time of closure based upon the contaminants subject to treatment, the effectiveness of the selected technology, and the ability of equipment to be effective in a highly radioactive environment. Equipment to be disposed of as solid waste will be disposed of in accordance with applicable local, state, and federal requirements. In some cases, the contaminated equipment may be dismantled, packaged, and transported to an onsite or offsite treatment, storage, and disposal facility. Section 6.3 describes available storage, treatment, and disposal options. Hazardous waste determinations will be performed on waste in accordance with 40 CFR 262.11 (2002).

## 6.2 Equipment and Structures to be Reused

The following equipment and structures are designated for potential reuse and will be decontaminated if they become contaminated during WM-184, WM-185, and WM-186 closure activities:

- Tank closure equipment—grout delivery equipment, wash ball, heel sampling equipment, video equipment, tank lighting
- Trucks—utility, flat-bed, and dump
- Cranes, backhoes, front-end loaders, excavator
- Temporary vessel off-gas system—blower, filter skids, condensate accumulation receiver tank, and ducting
- Decontamination equipment (line spray and valve box washing systems)
- Grout system—pump and piping

- Radiological protection equipment—shielding and large area containment tents
- Buildings—temporary enclosure and construction trailers
- Miscellaneous—pipe-cutting tools, liquid catches, buckets, brushes, etc.
- Utilities—electrical power (protective devices, conductors, distribution systems), water (pressure regulators, control valves, distribution/delivery systems), steam, and/or air distribution systems as deemed appropriate
- Direct heel sampling pump or simple sampler.

All equipment and structures that have documented contamination, visible signs of contamination, or known contact with waste materials will be decontaminated. Also, the contaminated equipment may be dismantled, packaged, and transported to an onsite storage/treatment facility for decontamination before reuse (see Section 6.3). For example, grout system piping may require decontamination in the INTEC debris treatment facilities before reuse.

## 6.3 Closure-Generated Waste

INTEC storage and treatment systems (e.g., PEW evaporator and TFF) may be used to store and treat wastes generated from the following sources:

- Valve box covers, valve boxes, and drain lines
- Vaults, vault sumps, and liquid removal lines to tanks and to the PEW evaporator
- Pipe encasements
- Condenser pit covers, pits, vessel off-gas lines, and vessel off-gas drain lines
- Purge liquids and decontamination solutions.

Alternatives for treatment and disposal methods for the liquid sodium-bearing and calcined wastes are addressed in the *Idaho High-Level Waste and Facility Disposition Final Environmental Impact Statement* process (DOE 2002). If necessary, decontamination materials and residues (e.g., personal protective equipment, sampling equipment, and HEPA filters) will be placed in containers labeled with the date of accumulation and a barcode identifier, sampled and analyzed, and held within the TFF as mixed, low-level, or transuranic waste. Based on process knowledge and the results of analysis, closure waste will be managed to ensure proper handling, treatment, storage, and disposal. Examples include, but are not limited or restricted to, the following:

- HEPA filters determined to be waste or debris may be transferred to CPP-659 New Waste Calcining Facility (NWCF) HEPA Filter Storage prior to treatment in the CPP-659 NWCF HEPA Filter Leach System. These HEPA filters will be disposed of either onsite at the Radioactive Waste Management Complex (RWMC) or offsite. Filter leaching will be necessary before disposal at RWMC.
- Hazardous or mixed waste may be accumulated within the area of closure and either sent offsite for treatment and disposal or sent to CPP-1619, the Hazardous Chemical and Radioactive Waste

Storage Facility, before shipment offsite. If hazardous waste generated from the closure activity is maintained within the boundaries of Tanks WM-184, WM-185, and WM-186 closure, the 90-day storage limit will not apply; all other handling, packaging, and inspection rules will apply to protect human health and the environment. The HWMA/RCRA facility closure requirements specify that the boundaries applicable to cleanup of closed facilities are the unit boundaries of the unit being closed. The boundaries for DOE HLW facility closures are based on the performance assessment conducted during closure activities (DOE-ID 2003c).

- Low-level radioactive waste can be sent to the Waste Reduction Operations Complex/Power Burst Facility for storage, volume reduction, and stabilization before disposal at RWMC. Mixed low-level waste may be managed similar to the low-level radioactive waste, except that disposal may include an offsite facility.

If applicable, fluids from decontamination may be contained within a work/closure area or collected in containers until characterization results are obtained to ensure compliant storage and/or treatment and disposal.

## 6.4 Management of Excavated Soils

Management of soils excavated during TFF closure activities will be conducted consistent with the approved methods outlined in the INTEC C40 Valve Box Soil Work Plan (INEEL 2000c). Soil excavated during TFF closure activities either will be returned to the excavation or managed in accordance with applicable HWMA requirements within the 24-month timeframe. TFF closure actions, which may include soil excavation, are expected to require a typical construction season, but may be delayed by unexpected circumstances. The project may require excavation of about 20 $yd^3$ of soil. Soil excavated during TFF closure activities will be used as backfill for this project only.

### 6.4.1 Excavation

One or more construction piles will be established immediately adjacent to the excavation where excavated soil will be held temporarily before transfer to a staging pile. Transfer will be accomplished using TFF-approved equipment (e.g., backhoe, front-end loader, hand shovels, vacuum, and excavator). These temporary construction piles are separate from the soil staging piles. Soil from the construction piles will be removed (down to approximately the last 6 in.) at the end of each day and then covered to prevent spread of loose soil.

### 6.4.2 Staging

Staging piles, as used for this project, will provide temporary staging of soil (no longer than 24 months) before reuse as a backfill for the TFF closure project or placement into containers for long-term management. Using staging piles will provide a reliable, effective, and protective option for staging soil before use as backfill. Soil contaminated at levels above 50 mr/hr (on or near contact) will not be put directly into staging piles but will be placed into containers (probably metal boxes or industrial-duty sacks or bags) to prevent possible spread of radiological contamination. Each container will be marked to indicate the location and depth at which the soil originated. This soil also will be placed back into the excavation near the depth and location of origination. Information on the location, depth, and level will be provided to the CERCLA program for resolution at final closure.

The staging piles will be placed on a double layer of an impermeable liner to prevent contamination of underlying soil or asphalt. The piles will be covered with impermeable material to prevent windblown spread of radionuclides and hazardous constituents. The covers also will prevent intrusion and percolation of precipitation through the soil. The covers will be secured to the liner and to each other using standard methods such as timbers and sandbags. Netting will be placed over the covers to aid in preventing wind damage. Precipitation run-off from the covers will be diverted away from the piles and then away from the TFF area through the existing storm water diversion system. The same diversion system will prevent precipitation run-on. The covers will be lifted or removed to allow working access to the staging pile as required. The staging pile will be re-covered and the cover secured at the end of each day.

Soil potentially contaminated with hazardous waste that has been placed into containers will not be staged in a HWMA/RCRA regulated treatment, storage, or disposal facility such as CPP-1617. The containers will be managed within the area of contamination as if they are in a less-than-90-day storage area until the soil is returned to the excavation as backfill. Excess soil, if any, will be managed in accordance with a formal hazardous waste determination and any applicable no-longer-contained-in determination. For the purpose of the TFF closure project, soil placed into containers for radiological control will be deemed no different than soil placed into staging piles; land disposal restriction requirements will not be violated.

### 6.4.3 Soil Emplacement as Backfill

Soil will be used as backfill in a way that does not significantly increase risk at the TFF either through direct exposure to radiation or by migration of contaminants. Soil will generally be placed back into the excavation in reverse order of removal (last-out, first-in). Soil emplacement in the excavation will be completed such that the site profile/condition before and after the project is consistent.

### 6.4.4 Soil Tracking

A single one-time-only waste stream will be established for tracking the management of the soil associated with closure of each TFF tank. The INEEL Integrated Waste Tracking System (IWTS) material profile will track excess soil placed into containers for long-term management. For soil used as backfill, only the volume will be tracked via the IWTS under a single-container profile tied back to the waste stream.

Several steps will be used to track soil during excavation, staging, and backfill activities. Radiological control personnel will complete necessary surveys during all soil movement.

Log sheets will be completed during initial excavation and when soil is used as backfill. These forms allow tracking of soil from the excavation to a staging pile; from the staging pile to backfill; placement into containers for radiological control; and use of containerized soil as backfill. The log sheets also provide a means to initially identify containers used for long-term storage of excess soil. These log sheets will be retained as part of the operating record.

# 7. MAXIMUM EXTENT OF THE OPERATION UNCLOSED

Closure of Tanks WM-184, WM-185, and WM-186 and the final closure of the TFF represent a partial closure of the INEEL facility. Final closure of the remaining HWMA/RCRA-regulated operational units at the INEEL will be conducted in accordance with applicable interim status or approved HWMA/RCRA Part B closure plans. In accordance with the information required under IDAPA 58.01.05.009 (2002) (40 CFR 265.112(b)(2), 2002), “the maximum extent of the operation which will be unclosed during the active life of the facility” must be identified. Therefore, an estimate of the maximum extent of operations that will remain unclosed (open) at the INEEL after closure of Tanks WM-184, WM-185, and WM-186 is to be determined. An estimate of the maximum extent of operations that will remain unclosed on the entire INEEL facility is available in the *HWMA/RCRA Part A Permit Application for the Idaho National Engineering and Environmental Laboratory* (DOE-ID 2000c) and other approved HWMA/RCRA Part B permits for the INEEL.

# 8. TIME ALLOWED FOR CLOSURE/EXTENSION

IDAPA 58.01.05.009 (2002) (40 CFR 265.113, "Closure, Time Allowed for Closure," 2002) requires that closure of the TFF must commence within 90 days after receiving the final volume of hazardous wastes or within 90 days after approval of the closure plan, whichever is later. The regulations allow DEQ to approve a longer period to commence closure, provided

- "The activities required to comply with this paragraph will, of necessity, take longer than 90 days to complete; and"

- The operator "has taken and will continue to take all steps to prevent threats to human health and the environment, including compliance with all applicable interim status requirements."

The second modification to the Consent Order (IDHW 1998) specifies that DOE must cease use of Tanks WM-182 through WM-186 by June 30, 2003, and the remaining tanks by December 31, 2012. Ceasing use of the tanks means that DOE must empty the tanks to their heels, that is, the liquid level remaining in each tank must be lowered to the greatest extent possible by the use of existing transfer equipment. As described in Section 1, closure of the TFF will be conducted in phases, with partial closures of groups of tanks leading to final closure of the TFF. IDAPA 58.01.05.009 and 40 CFR 265.113 also require that closure activities be completed in accordance with the approved closure plan "within 180 days after receiving the final volume of hazardous wastes" or "within 180 days after approval of the closure plan, if that is later." The director of DEQ may approve an extension to the closure period provided it is demonstrated that

- "The activities required to comply with this paragraph will, of necessity, take longer than 180 days to complete; and"

- The operator "has taken and will continue to take all steps to prevent threats to human health and the environment from the unclosed but not operating hazardous waste management unit or facility, including compliance with all applicable interim status requirements."

Closure activities for the TFF tanks are anticipated to take longer than 180 days to complete for the following reasons:

- The highly radioactive wastes stored in the tanks will require much of the sampling and waste removal work to be performed using remote handling technology, which will require significant lead times to set up and conduct

- The approach for partial closure of the TFF tanks in sequence will require the continued availability of storage space in other tanks and treatment capacity in the INTEC waste treatment systems for the wastes generated; operational timeframes in these systems do not allow closure within 180 days

- Closure to performance-based standards will involve an iterative process of decontamination, sampling, analysis, data review, and possibly, additional decontamination.

For these reasons, the closure of each set of tanks in the TFF is likely to require much longer than 180 days. Current planning estimates suggest each partial closure phase will require 3 to 5 years. An extension to the 180-day period for Tanks WM-184, WM-185, and WM-186 is requested to 2,001 days.

Quarterly reports will be provided for the closure of Tanks WM-184, WM-185, and WM-186. These reports will be integrated with the quarterly reports for WM-182 and WM-183. The reports will be provided to DEQ within 30 days of the end of each quarter of the fiscal year. The reports will identify the status of the closure activities, identify the status of the entire closure schedule, and outline any issues or concerns relative to the milestone of completing partial closure. Reporting will begin at the end of the first quarter after approval of the closure plan. The reports will be submitted no later than January 31, April 30, July 31, and October 31 of each year (the same schedule as for WM-182 and WM-183), and will continue until closure is complete. Table 6 lists the durations and descriptions of the planned activities for closure of Tanks WM-184, WM-185, and WM-186.

Finally, IDAPA 58 and 40 CFR 265.112(a) (2002) require that by May 19, 1981, or by six months after the effective date of the rule that first subjects a facility to provisions of this section, the owner or operator of a hazardous waste management facility must have a written closure plan. This closure plan is being submitted in accordance with the Consent Order, which requires submittal of the first closure plan on or before December 31, 2000, as described in the second modification to the Consent Order (IDHW 1998).

The integration of HWMA/RCRA closure and DOE closure is vital to success of the TFF closure. Implementation of the DOE closure plan by DOE must be coordinated with the implementation of the HWMA/RCRA closure plan by DEQ. Both a DOE Authorization to Proceed and State of Idaho approval must be obtained before any irreversible closure actions may begin. Preliminary tank washing may commence before these closure plans are approved.

Table 6. Durations and descriptions of planned activities scheduled for WM-184, WM-185, and WM-186 closure.[a]

| Duration | Description |
|---|---|
| 0 day | Approval of partial closure plan and receive DOE “Authorization to Proceed”[b] |
| 328 days | Remove waste and decontaminate Tank WM-184 |
| 339 days | Evaluate results, grout, and close |
| 328 days | Remove waste and decontaminate Tank WM-185 |
| 339 days | Evaluate results, grout, and close |
| 328 days | Remove waste and decontaminate Tank WM-186 |
| 339 days | Evaluate results, grout, and close |
| 60 days | Submit PE supporting documentation (this time is in addition to the 2001 days for closure) |

a. The sequence of tank closure may change based on timing and logistics.

b. Waste removal, decontamination, and evaluation will commence on or before approval of the partial closure plan. Grouting will commence after DOE “Authorization to Proceed” is received.

# 9. CLOSURE PLAN MAINTENANCE AND AMENDMENTS

In accordance with IDAPA 58.01.05.009 (2002) (40 CFR 265.112(a), 2002), a copy of the most current version of the closure plan will be maintained by the facility until closure is certified. The plan will be furnished to the DEQ Director, upon request, any time before closure certification. This closure plan will be modified, as necessary, in accordance with IDAPA 58.01.05.009 [40 CFR 265.112(c)] and as follows:

- Whenever changes in operating plans or facility design significantly affect the closure plan
- If there is a change in the expected year of closure
- If, in conducting closure activities, unexpected events require a modification
- If a change in state or federal laws or regulations require a change in the closure plan
- If the regulatory authority requests modification of the closure plan in accordance with IDAPA 58.01.05.009 [40 CFR 265.112(c)(4)]
- At the time of closure to address the schedule for closure, changes to regulatory standards for cleanup, biased sampling based on the operating record, specific decontamination methods/technologies to be employed, changes to how and where disposal of equipment and structures will take place, and other changes necessary to accomplish the "clean closure" performance standard.

Written notifications or requests for amendment or modification of this closure plan will be submitted, along with a copy of the amended plan, to the appropriate regulating agency

- 60 days before a proposed changed in operating plans or design of the waste management unit or facility; or
- No later than 60 days after an unexpected event occurs that affects the closure plan; or
- No later than 30 days after an unexpected event occurs during closure (IDAPA 58.01.05.009 and 40 CFR 265.112(c).

# 10. CERTIFICATION OF CLOSURE

Certification of closure will be provided by an independent Idaho-registered PE and the facility contractor and/or DOE-ID, in accordance with IDAPA 58.01.05.009 (2002) (40 CFR 265.115, 2002), at final closure of the TFF system. It is not required to certify partial closures (NTIS: SUB-9224-98-002, EPA: 530-R-98-005b [EPA 1998]). The TFF tanks will not be certified closed until all the tanks have been decontaminated and the waste removed.

Within 60 days of completion of final closure covered by this plan, the owner or operator must submit to the DEQ Director, by registered mail, a certification that the hazardous waste management unit has been closed in accordance with the specifications in the approved closure plan. The certification will be signed by the owner or operator and by the PE. Documentation supporting the PE's certification must and will be furnished to the DEQ Director. The certification of closure as stated in 40 CFR 265.115 will be met with these actions. PE certification information will be submitted to DEQ 60 days after completion of this closure plan for Tanks WM-184, WM-185, and WM-186. Records of each partial closure certification will be stored at the INEEL for certification upon final closure.

As data are collected in the partial closures of the TFF, the data will be combined using the statistical methods shown in Appendix D. Final closure conditions for the TFF will be determined when the data from all the tanks and ancillary equipment is compared to the TFF action levels. The 95% upper confidence of the mean of all samples will be compared to the action levels. Tank and ancillary equipment sample populations may be considerably different; therefore, two or more upper confidence level calculations may be performed and compared to action levels.

If closure of the TFF systems to the landfill closure standard is necessary, a "Notice in Deed" and survey plat will be submitted to the Butte County Courthouse in accordance with IDAPA 58.01.05.009 (40 CFR 265.119, 2002), and the tanks will be closed in accordance with the Contingent Plan (DOE-ID 2003). The survey plat will be prepared and certified by an Idaho professional land surveyor and will indicate the location and dimensions of the tank system that requires closure to the landfill standard. The "Notice in Deed" will state

- That the land has been used to manage hazardous waste
- That land use is restricted under IDAPA 58.01.05.009 (40 CFR 265.119)
- That the facility contractor and/or DOE-ID have an obligatory commitment to restrict disturbance of the closed landfill unit.

In addition, a record describing the type, location, and quantity of hazardous waste disposed of in any and all WM-184, WM-185, and WM-186 tank system components will be submitted to DEQ and the Butte County Commissioners (IDAPA 58.01.05.009 [40 CFR 265.119]).

The PE certification information will document all closure activities so there is adequate information provided for each phase of closure. Closure activities for Tanks WM-184, WM-185, and WM-186 under this closure plan will be considered complete upon submittal of the supporting documentation from the independent PE to DEQ.

# 11. COST, FINANCIAL ASSURANCE, AND LIABILITY REQUIREMENTS

The INEEL is owned and operated by the U.S. Government. Therefore, the facility is, in accordance with IDAPA 58.01.05.009 (2002) (40 CFR 265.140(c), 2002), exempt from the financial requirements of IDAPA 58.01.05.009 (40 CFR Part 265, Subpart H, 2002).

# 12. REFERENCES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# Appendix A

# Detailed INTEC Facility Description

# Appendix A

# Detailed INTEC Facility Description

This appendix provides a detailed description of the Idaho Nuclear Technology and Engineering Center (INTEC) Tank Farm Facility (TFF) to further support the closure plan. The facilities within the TFF and associated equipment and processes are described.

## A-1. INTEC AND TANK FARM FACILITY DESCRIPTION

INTEC, formerly known as the Idaho Chemical Processing Plant, is located in the south-central portion of the Idaho National Engineering and Environmental Laboratory (INEEL). INTEC began operations in 1953 and was historically a fuel reprocessing facility for defense projects, research, and storage of spent nuclear fuel. The high-level radioactive liquid wastes (HLLW) generated from fuel reprocessing operations were stored in stainless-steel storage tanks contained in concrete vaults at the TFF.

In 1992, the Department of Energy (DOE) decided to end the fuel reprocessing mission at INTEC. This decision led to the phase-out of fuel dissolution, solvent extraction, product denitration, and other processes. The current mission of INTEC is to receive and store spent nuclear fuels and radioactive wastes, treat and convert wastes, and develop new technologies for waste and waste management for DOE. Employees are to do this in a cost-effective manner that protects the safety of INEEL employees, the public, and the environment.

The INTEC facility is situated on approximately 200 acres (80 ha) that lie within a perimeter fence. Located outside the INTEC perimeter fence are parking areas, a helicopter landing pad, the waste water treatment lagoon, various pits and percolation ponds, and the Tank Farm Project Support Facility. These areas occupy approximately 55 acres (22 ha).

## A-2. TFF TANK CONTENTS AND CONSTRUCTION INFORMATION

The TFF comprises

- Nine 300,000-gal and two 318,000-gal active stainless-steel tanks (hereafter referred to as 300,000-gal tanks), each of which is contained within a concrete vault
- Four inactive 30,000-gal stainless-steel tanks
- Valve boxes, encasements, and various process and instrumentation piping associated with the tanks (INEEL 2000).

The physical layout of INTEC and the TFF is depicted in Figure A-1. A conceptual view of the TFF is depicted in Figure A-2.

### A-2.1 300,000-gal Tanks

The 300,000-gal storage tanks, WM-180 through WM-190, are contained in belowground, unlined, octagonal (WM-180 through WM-186) or square (WM-187 through WM-190) concrete vaults. A diagram of Tank WM-182 is shown in Figure A-3 as an example of the construction and design of the tanks. The tanks are stand-alone, stainless-steel, cylindrically-shaped vessels. Each tank is

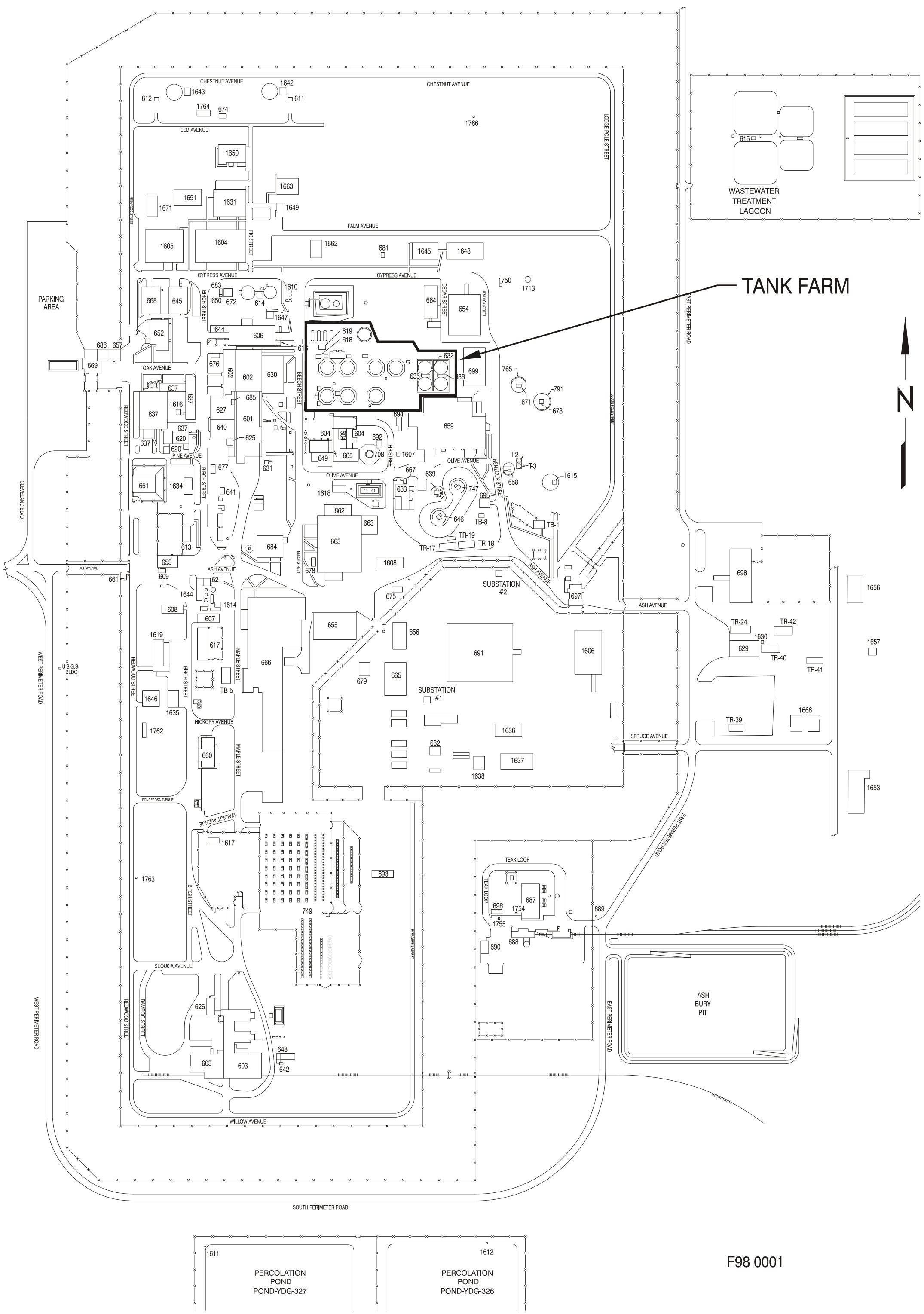


Figure A-1. Location of the TFF at INTEC.

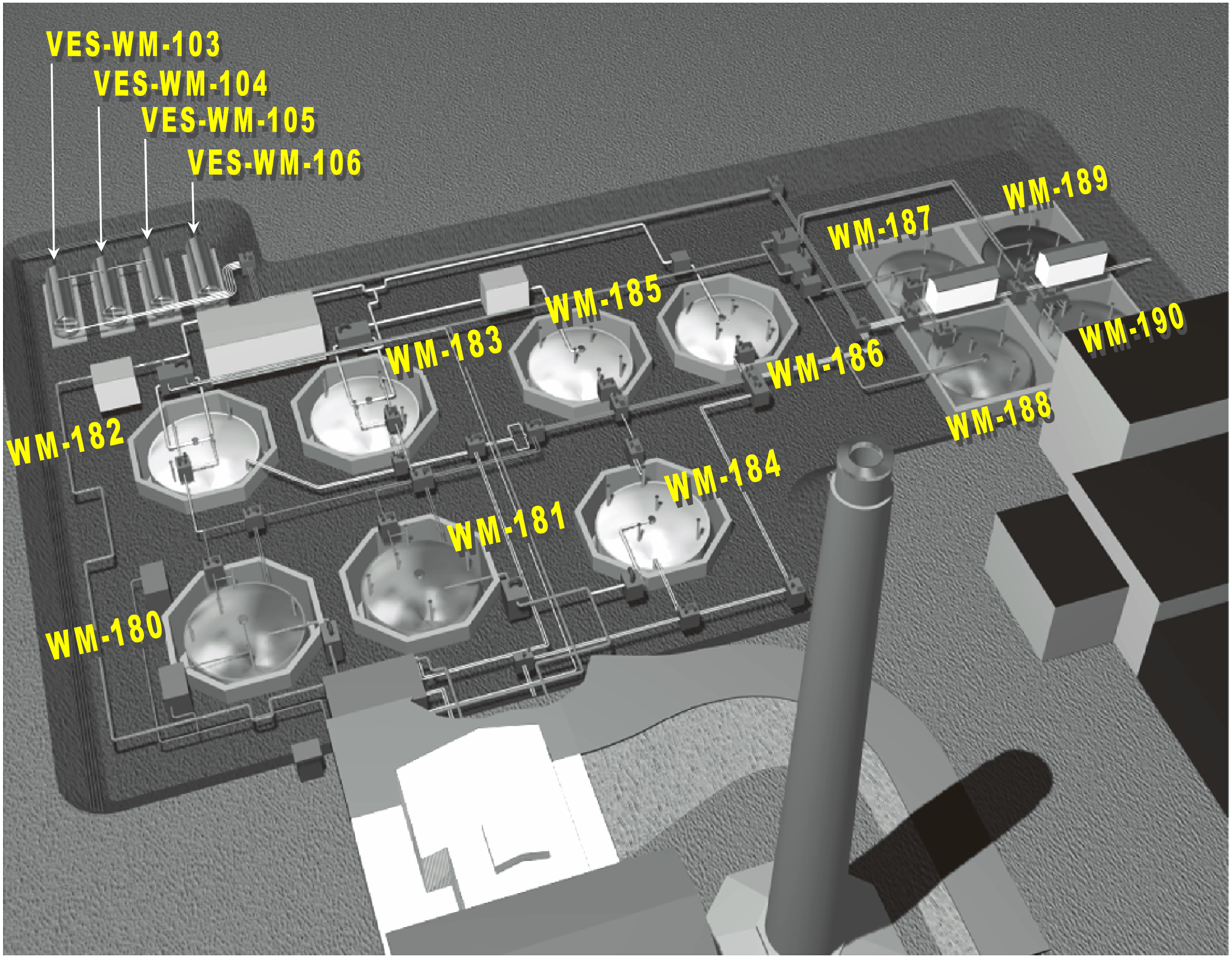


Figure A-2. Conceptual overview of the TFF.

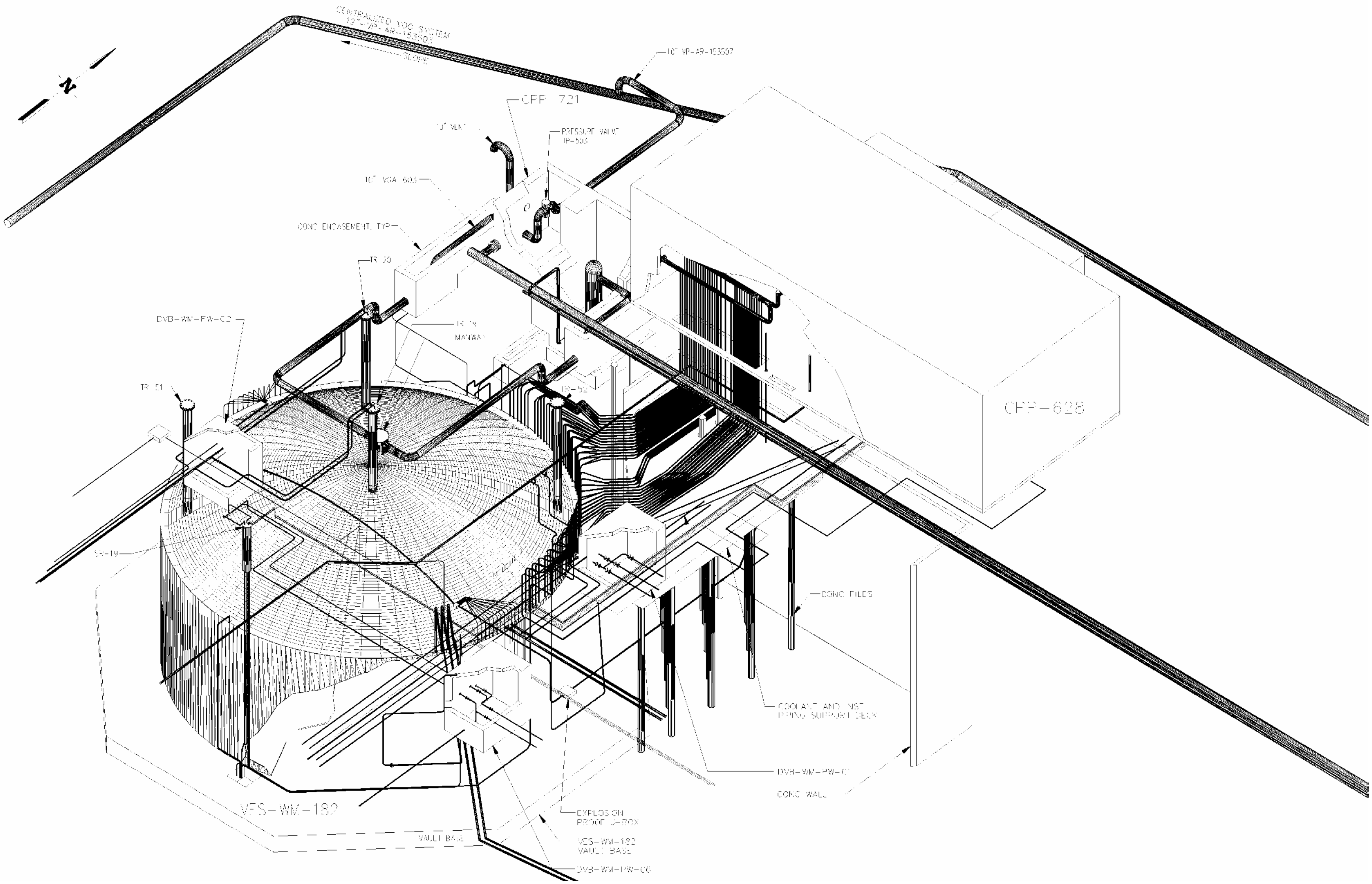


Figure A-3. Cutaway view of Tank WM-182.

administratively limited to storing 285,000 gal of liquid waste. The inside tank diameter and wall height are 50 ft (15 m) and 21 ft (16.4 m), respectively, with the exception of the 23-ft (7.0-m) high walls for Tanks WM-180 and WM-181. The higher walls for these two tanks provide a storage capacity of 318,000 gal for each tank.

Tanks WM-182 through WM-190 are constructed with an 11-in. (28-cm) wide horizontal plate (WM-180 and WM-181 have a 4-in. [10-cm] plate) that connects the top of the tank wall to the dome. This horizontal plate provides a flat surface for process and instrumentation pipelines to penetrate the tank. Equally spaced gussets support the plate from underneath. Tank domes are spherical in shape and rise above the tank wall from 8.5 to 8.7 ft (2.6 to 2.7 m).

Eight of the eleven tanks contain stainless-steel cooling coils (all except WM-181, -184, and -186). The cooling coils maintain the liquid waste temperature below 95°F (35°C) for fluoride-containing waste. The liquid waste is maintained below these temperatures to minimize tank corrosion. The lower tank temperature also reduces the liquid surface evaporation rate. Demineralized water in the cooling coils, along with chromate additives, circulates through a closed system and is cooled by secondary cooling water.

Access to the 300,000-gal tanks is provided through risers. Each tank has four to five 12-in. diameter risers. Tanks WM-184 through WM-190 also have 18-in. (46-cm) diameter risers (Tanks WM-184 through WM-188 have one 18-in. riser, WM-189 and WM-190 have two 18-in. risers). Most risers have equipment installed in them, such as radio frequency probes for level measurement, corrosion coupons, or waste transfer equipment (steam jets and airlifts). Two steam jets are located inside each tank, with the exception of WM-189 and WM-190; these two tanks have one steam jet and one air lift pump. A single steam jet can transfer waste out of a tank at approximately 50 gal/min. An airlift can transfer waste out of a tank at approximately 35 gal/min. Table A-1 provides general construction information on the 300,000-gal tanks.

## A-2.2 30,000-gal Tanks

The four, inactive 30,000-gal tanks are stainless-steel belowground tanks on reinforced concrete pads. The tanks have a diameter of about 11.5 ft, are 38 ft long, and are covered by compacted gravel. Tanks WM-103, -104, -105, and -106 were buried at depths of 28.5, 29.0, 29.5, and 29.5 ft (8.69, 8.84, 8.99, and 8.99 m), respectively. Like the 300,000-gal tanks, the 30,000-gal tanks do not have secondary containment that can be certified to meet Hazardous Waste Management Act (HWMA) /Resource Conservation and Recovery Act (RCRA) requirements (State of Idaho 1983; 42 USC 6901 1976). Unlike the 300,000-gal tanks, the 30,000-gal tanks do not have vaults.

The tanks rest on concrete slabs that are 47.5 ft long × 17 ft wide × 1.25 ft (14.5 × 5.2 × 0.381 m) thick. These slabs were constructed with a 0.75 × 1 ft (0.23 × 0.3-m) high curb surrounding the slab perimeter to contain leaking waste. A gravel pad was placed inside the curb. Sumps, 2 × 2 × 2 ft (0.6 × 0.6 × 0.6-m) deep were cast into the northeast corner of each concrete slab.

Each tank has a total volume of 30,750 gal (116,400 L). The tanks are horizontal cylinders with American Society of Mechanical Engineers (ASME) dished heads attached on both ends. Generalized information and tank dimensions can be found in Table A-2.

Underground pillars anchored to bedrock support the concrete pipe encasements associated with the 30,000-gal tanks. The base slabs, which the tanks rest on, sit on undisturbed soil.

All four tanks contain stainless-steel, closed loop, re-circulating cooling coils to control liquid waste temperature, evaporation rate, and condensation accumulation. Base slab sump access is provided by a

Table A-1. Design information summary for the 300,000-gal tanks at the TFF.[a]

| | WM-180 | WM-181 | WM-182 | WM-183 | WM-184 | WM-185 | WM-186 | WM-187 | WM-188 | WM-189 | WM-190 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Design organization | Foster-Wheeler | Foster-Wheeler | Blaw-Knox | Blaw-Knox | Blaw-Knox | Fluor Corp. | Fluor Corp. | Fluor Corp. | Fluor Corp. | Fluor Corp. | Fluor Corp. |
| Tank subcontractor | Chicago Bridge and Iron | Chicago Bridge and Iron | Chicago Bridge and Iron | Chicago Bridge and Iron | Chicago Bridge and Iron | Chicago Bridge and Iron | Chicago Bridge and Iron | Hammond Iron | Hammond Iron | Industrial Contractors | Industrial Contractors |
| Years constructed | 1951–1952 | 1951–1952 | 1954–1955 | 1954–1955 | 1954–1955 | 1957 | 1955–1957 | 1958–1959 | 1958–1959 | 1964 | 1964 |
| Initial service date | 1954 | 1953 | 1955 | 1958 | 1958 | 1959 | 1962 | 1959 | 1963 | 1966 | Spare |
| Design codes | Unknown | Unknown | API-12C | API-12C | API-12C | API-12C | API-12C | API-12C | API-12C | API-650 | API-650 |
| Cooling coils | Yes | No | Yes | Yes | No | Yes | No | Yes | Yes | Yes | Yes |
| Tank diameter (ft) | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 |
| Tank height to springline (ft) | 23 | 23 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 |
| Tank capacity (gal) | 318,000 | 318,000 | 300,000 | 300,000 | 300,000 | 300,000 | 300,000 | 300,000 | 300,000 | 300,000 | 300,000 |
| Lower tank thickness (in.) | 0.3125 | 0.3125 | 0.3125 | 0.3125 | 0.3125 | 0.3125 | 0.3125 | 0.3125 | 0.3125 | 0.3125 | 0.3125 |
| Upper tank thickness (in.) | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Corrosion allowance (mils) | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 |
| Type of stainless steel | 347 | 347 | 304 L | 304 L | 304 L | 304 L | 304 L | 304 L | 304 L | 304 L | 304 L |
| Design specific gravity | 1.3 | 1.3 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 |
| Physical characteristic | | Dimension | | | | | | | | | |
| Dome height | | 8.7 ft (WM-180 and WM-181)[b] | | | | 8.5 ft (WM-182 through WM-190)[b] | | | | | |
| Approximate total tank volume | | 2,000 yd$^3$ (WM-180 and WM-181)[b,c] | | | | 1,825 yd$^3$ (WM-182 through WM-190)[b,c] | | | | | |
| Approximate dome volume | | 330 yd$^3$ (WM-180 and WM-181)[b,d] | | | | 300 yd$^3$ (WM-182 through WM-190)[b,d] | | | | | |

a. Data taken from *Idaho Nuclear Technology and Engineering Center Tank Farm Facility Conceptual DOE and HWMA/RCRA Closure Approach* (INEEL 2000).

b. Values shown in the table are approximations to aid in cost estimation and provide a general tank description.

c. Estimated volume is based on the physical tank volume, not the tank capacity.

d. Volume calculated using standard spherical cap equation, a diameter of 50 ft, and appropriate dome height.

Table A-2. Design information summary for the 30,000-gal tanks at the TFF.

| Tank Identification Number | WM-103 | WM-104 | WM-105 | WM-106 |
|---|---|---|---|---|
| Design organization | Blaw-Knox Company | Blaw-Knox Company | Blaw-Knox Company | Blaw-Knox Company |
| Vendor | Alloy Fabricators | Alloy Fabricators | Alloy Fabricators | Alloy Fabricators |
| Years constructed | 1954–1955 | 1954–1955 | 1954–1955 | 1954–1955 |
| Total tank volume (gal) | 30,750 | 30,750 | 30,750 | 30,750 |
| Tank cylindrical length (ft) | 38 | 38 | 38 | 38 |
| Spherical heads (two per column) | ASME standard flanged and dished heads (≈2 ft deep) | ASME standard flanged and dished heads (≈2 ft deep) | ASME standard flanged and dished heads (≈2 ft deep) | ASME standard flanged and dished heads (≈2 ft deep) |
| Total tank length (ft) | 42 | 42 | 42 | 42 |
| Tank inner diameter (ft) | 11.5 | 11.5 | 11.5 | 11.5 |
| Tank wall thickness (in.) | 11/16 | 11/16 | 11/16 | 11/16 |
| Tank supporting base slab size (ft) | 47.5 × 17 × 1.25 thick | 47.5 × 17 × 1.25 ft thick | 47.5 × 17 × 1.25 thick | 47.5 × 17 × 1.25 ft thick |
| Liquid containment perimeter curb size (in.) | 12 high × 9 wide | 12 high × 9 wide | 12 high × 9 wide | 12 high × 9 wide |
| Tank access risers | Three 6-in. diameter | Three 6-in. diameter | Three 6-in. diameter | Three 6-in. diameter |
| | One 3-in. diameter | One 3-in. diameter | One 3-in. diameter | One 3-in. diameter |
| Sump riser (concrete pipe) | 24-in. diameter | 24-in. diameter | 24-in. diameter | 24-in. diameter |
| | Pipe wall is 3 in. thick | Pipe wall is 3 in. thick | Pipe wall is 3 in. thick | Pipe wall is 3 in. thick |
| Sump dimensions (ft) | 2 × 2 × 2 | 2 × 2 × 2 | 2 × 2 × 2 | 2 × 2 × 2 |
| Buried tank depths (dimensions to tank bottom) (ft) | 28.5 | 28.5 | 28.5 | 28.5 |

2-ft (0.6-m) diameter concrete riser that extends to grade level. A permanently installed sump jet pump obstructs the sump access riser interior.

Access to the 30,000-gal tanks is provided by three 6-in. and one 3-in. diameter risers that reach to grade level. Tank jets are connected through the tank personnel access and extend underground to the other TFF locations. Tanks WM-103 and WM-104 are installed with four steam jets, while Tanks WM-105 and WM-106 are installed with two steam jets for liquid removal.

## A-2.3 Vaults

The vault floors are approximately 45 ft (14 m) belowground. The vaults containing the tanks are of three basic designs: monolithic octagonal, pillar and panel octagonal, or monolithic square. The vault roofs are covered with approximately 10 ft (3 m) of soil to provide radiation shielding. The vault roofs are 6-in. (20-cm) thick concrete. Details of the various vaults are provided in Table A-3.

### A-2.3.1 Monolithic Octagonal Vaults

The two oldest tanks at the TFF, WM-180 and WM-181, were constructed from 1950 to 1952 and are contained in poured-in-place monolithic octagonal concrete vaults. These are the only vaults that have been qualified through analytical modeling to meet seismic criteria. The vault floors are octagonal and were poured on bedrock. They are flat with sump areas cast within the vault floor for liquid drainage. Vault CPP-180 (Tank WM-180) was installed with two sump areas: 2 × 2 × 4 ft (0.6 × 0.6 × 1 m) deep in the southeast corner and 2.5 × 2.5 × 2 ft (0.76 × 0.76 × 0.6 m) deep in the northeast corner. Vault CPP-781 (Tank WM-181) was installed with one sump area 2 × 2 × 4 ft (0.6 × 0.6 × 1 m) deep in the southwest corner. The concrete vault walls were cast once the vault floors were poured. The concrete vault roof was cast in place. The vault roof was constructed to rise at an angle from the vault walls and flatten toward the middle.

### A-2.3.2 Pillar and Panel Octagonal Vaults

The five tanks contained in vaults of pillar and panel octagonal construction, Tanks WM-182 through WM-186, were constructed from 1954 to 1957. Also in octagonal vaults, the tanks contained in the pillar and panel vaults are of prefabricated construction and, therefore, are not considered as robust as the tanks contained in monolithic vaults (Palmer et al. 1998). The pillar and panel vaults were not analyzed for and probably would not qualify for Performance Category (PC)-4 seismic criteria.[a] A diagram of the pillar and panel vault design is presented in Figure A-4. The octagonal concrete floors were poured on bedrock. Each floor has a 4-in. (10-cm) slope, beginning at the floor center and tapering to the curb. This slope creates a conical shaped floor. Sump areas 1 × 1 × 1 ft (0.3 × 0.3 × 0.3 m) deep located on the north and south side of each vault, were cast within the vault floor. There is a 6 × 6-in. (20 × 20-cm) curb cast 6 ft (2 m) in from the concrete base slab. The curb encloses an octagonal area 51 ft (16 m) wide, encircling a sand pad.

The vault walls are constructed of concrete pillars and panels. The roofs are constructed of similar materials.

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a. M. C. Swenson, INEEL, e-mail to P. A. Tucker, INEEL, “Seismic Qualification of 300,000-gal Tanks,” April 1999.

Table A-3. Design information summary for Vaults CPP-780 through CPP-786 and CPP-713.

| | CPP-780 | CPP-781 | CPP-782 | CPP-783 | CPP-784 | CPP-785 | CPP-786 | CPP-713 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | WM-180 | WM-181 | WM-182 | WM-183 | WM-184 | WM-185 | WM-186 | WM-187 | WM-188 | WM-189 | WM-190 |
| Design organization | Foster-Wheeler | Foster-Wheeler | Blaw-Knox | Blaw-Knox | Blaw-Knox | Fluor Corp. | Fluor Corp. | Fluor Corp. | Fluor Corp. | Fluor Corp. | Fluor Corp. |
| Years Constructed | 1951-1952 | 1951-1952 | 1954-1955 | 1954-1955 | 1954-1955 | 1957 | 1955-1957 | 1958-1959 | 1958-1959 | 1964 | 1964 |
| Vault type | Monolithic octagonal [a] | Monolithic octagonal [a] | Pillar and panel octagonal | Pillar and panel octagonal | Pillar and panel octagonal | Pillar and panel octagonal | Pillar and panel octagonal | Monolithic square [a] | Monolithic square [a] | Monolithic square [a] | Monolithic square [a] |
| Inside width (ft) | 56 | 56 | 58.9 | 58.9 | 58.9 | 58.8 | 58.8 | 56 | 56 | 56 | 56 |
| Wall thickness (ft) | 2.33 or 1.75 | 2.33 or 1.75 | 0.5 | 0.5 | 0.5 | 0.542 | 0.542 | N = 3.5<br>S = 3.5<br>W = 1.5<br>E = 3.5 | N = 3.5<br>S = 3.5<br>W = 1.5<br>E = 3.5 | N = 3.5<br>S = 3.5<br>W = 3.5<br>E = 1.5 | N = 3.5<br>S = 3.5<br>W = 3.5<br>E = 1.5 |
| Inside vault wall height (ft) | 27.33 | 27.33 | 32 | 32 | 32 | 32 | 32 | 32.6 | 32.6 | 32.6 | 32.6 |
| No. of vault risers and sumps | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 |
| Maximum roof thickness (ft) | 5.75 | 5.75 | 3.66 | 3.66 | 3.66 | 3.5 | 3.5 | 4.5 | 4.5 | 4.0 | 4.0 |
| Minimum roof thickness (ft) | 1.25 | 1.25 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Vault top to grade (ft) | 6.75 | 6.75 | 8.5 to 9 | 9 to 9.5 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| Total vault volume ($yd^3$) | 3,386 | 3,386 | 3,229 | 3,229 | 3,229 | 3,229 | 3,229 | 3,737 | 3,737 | 3,737 | 3,737 |
| Vault volume with tank in vault ($yd^3$) | 1,384 | 1,384 | 1,404 | 1,404 | 1,404 | 1,404 | 1,404 | 1,911 | 1,911 | 1,911 | 1,911 |

a. Cast-in-place.

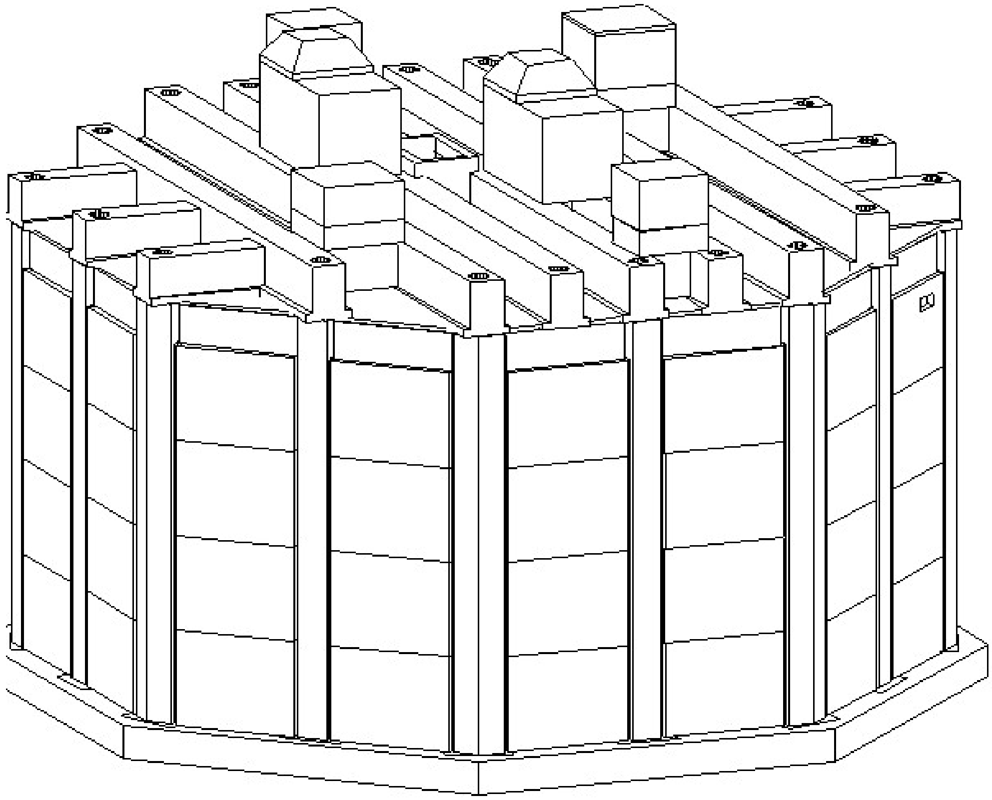

Figure A-4. Pillar and panel vault design at the INTEC TFF.

### A-2.3.3 Monolithic Square Vaults

The four tanks contained in reinforced, poured-in-place, monolithic square, four-sectioned (“four pack”) concrete vaults, Tanks WM-187 through WM-190, were constructed from 1958 to 1964. The vaults of these tanks are believed to meet PC-4 criteria, but the analysis for qualification was not performed (Palmer et al. 1998; Swenson 1999 [see footnote a, page A-2]). The square concrete vault floors were poured side by side on bedrock. The floors are constructed with a 4-in. (10-cm) slope, beginning at the floor center and tapering to the curb. The slope creates a conical-shaped floor similar to the pillar and panel vaults. Two sump areas, 12 × 12 × 12 in. (30 × 30 × 30 cm.), are cast within the vault floors of WM-187 and WM-188. WM-189 and WM-190 have three sumps with two (hot sumps) measuring 12 × 12 × 36 in. (30 × 30 × 90 cm) and one (cold sump) measuring 3 × 5 × 9ft (0.9 × 1.5 × 2.3 m) deep. The sumps are located in the northwest and southeast corners for the WM-187 and WM-189 vaults, and the northeast and southwest corners for the WM-188 and WM-190 vaults. A 6 × 6-in. (20 × 20-cm) octagonal curb was installed inside the square vault. The curb creates an octagonal area 51 ft (16 m) wide, encircling a sand pad.

## A-2.4 Transfer Equipment

Waste transfer, cooling, decontamination, instrumentation, and vessel off-gas pipelines are plumbed to individual tanks and vaults. The waste transfer pipe running from the valve boxes to just outside the vault walls is encased in concrete enclosures with stainless-steel liners to prevent radioactive waste from escaping. The concrete enclosures do not penetrate the vault. Pipes penetrate the vault via a pipe-in-pipe sleeve. Drains in each concrete encasement allow liquid from a leaking pipe or water infiltration to flow back to the nearest tank vault. Steam-powered sump jets are installed in the sumps on the north and south sides of each tank. The sump jets transfer liquid from the vaults to the respective tanks.

Jet pumps are installed to remove liquid from the tanks. These jet pumps are located 3 to 9.5 in. (8 to 24 cm) above the tank floor. Permanent steam lines are connected to each jet pump and routed through underground piping to steam sources within the TFF Control House (CPP-628). A double-contained process waste is routed underground from the jet pumps to the main transfer/filling system.

All primary waste lines that transport waste within the TFF are buried and enclosed in pipe encasements known as secondary containment. The four main types of TFF secondary containment initially used are

1. Split tile (ceramic cast pipe with concrete joints)

2. Stainless-steel-lined concrete troughs

3. Direct-buried pipes in concrete

4. Double-walled stainless-steel pipe.

During recent TFF upgrades, most pipe sections encased in ceramic tile were replaced or abandoned in place. Short sections of ceramic pipe still remain on the active line list that serves Tanks WM-180 and WM-181. These lines cannot be used unless authorized by upper management.

Any fluid leaking from a process line drains into an encasement and then into a valve box or vault sump. Leaking fluid is detected by radiation and/or level detection instrumentation. A leaking line is immediately taken out of service and is not reused until it has been repaired. Waste collected in the valve box or vault sumps is jetted to Tank WL-133 or drained to Valve Box C12. Wastes collected in Valve Box C12 also are jetted to WL-133. All wastes are then transferred to the process equipment waste (PEW) evaporator for processing.

### A-2.4.1 30,000-gal Tank Liquid Transfer Equipment

Permanent sump jet pumps are installed in each of the four sumps associated with these tanks. Liquid removal jet pumps are installed in each tank, with lines penetrating through the tank personnel access. The inlets to these tanks are currently disconnected but the outlets are still tied to the TFF piping system.

### A-2.4.2 C-Series Valve Boxes

Valve boxes, located where pipe runs change directions, were constructed to provide protection for pipe joints, improve valve access, increase protection to workers from contaminated soils, and reduce valve repair costs by minimizing ground excavation. Valve boxes were installed with sumps and attached drain lines to transfer liquid waste to vault sumps or the PEW evaporator in the event pipe encasement drains or process valve leaking occurs.

Each concrete valve box is reinforced and lined with stainless steel. Bitumastic #50, a material similar to tar thatch, was used as filler around pipe sleeves or on carbon steel piping. The approximate valve box dimensions are 6 ft long × 6 ft wide × 6.5 ft (2 × 2 × 2.0 m) high with a wall thickness of 6 in. (20 cm). Typically, valve boxes extend approximately 1 ft (0.3 m) aboveground.

### A-2.4.3 Process Waste Pipelines

During recent TFF upgrades, most pipe sections encased in split tile either were replaced or abandoned in place (footnote a, page A-2). Process waste lines and respective secondary containment are generally covered with 10 to 15 ft (3 to 4.6 m) of soil.

Any fluid leaking from a process line drains into an encasement and then into a valve box or vault sump. Leaking liquid is detected by radiation and level detection instrumentation. Waste collected in a valve box or vault sump is jetted to Tank WL-133 (located in building CPP-604) or drained to Valve Box C12. Waste collected in Valve Box C12 also is jetted to Tank WL-133. Waste from WL-133 is sent to the PEW evaporator for processing.

# A-3. REFERENCES


42 USC 6901 et seq., 1976, "Resource Conservation and Recovery Act of 1976."

INEEL, 2000, *Idaho Nuclear Technology and Engineering Center Tank Farm Facility Conceptual DOE HWMA/RCRA Closure Approach*, INEEL/EXT-99-01066, June.

Palmer, W. B., C. B. Millet, M. D. Staiger, and F. S. Ward, 1998, *ICPP Tank Farm Planning through 2012*, INEEL/EXT-98-00339, April.

State of Idaho, 1983, "Hazardous Waste Management," Idaho Statute, Title 39, "Health and Safety," Chapter 44, "Hazardous Waste Management," (also known as the Hazardous Waste Management Act of 1983).

# Appendix B

# Development of Action Levels for the HWMA/RCRA Closure of Tanks WM-184, WM-185, and WM-186

# Appendix B

# Development of Action Levels for the HWMA/RCRA Closure of Tanks WM-184, WM-185, and WM-186

The Idaho Nuclear Technology and Engineering Center (INTEC) Tank Farm Facility (TFF) Tanks WM-184, WM-185, and WM-186 are to be closed under HWMA/RCRA (State of Idaho 1983; 42 U.S. Code [USC] 6901, 1976) by removal of the waste currently contained in the tanks and decontamination of the internal tank surfaces. Compliance with the performance standard for closure of tank systems (40 CFR 265.111 and 265.197) is to be demonstrated for the tanks by sampling the final rinsate solutions from the decontamination efforts and comparing the resulting analytical data with action levels developed in this appendix. The action levels for the HWMA/RCRA closure of Tanks WM-184, WM-185, and WM-186 have been developed to ensure that the tanks, subsequent to completion of closure activities, will be left in a state that is protective of human health and the environment. This appendix was prepared to present the methodology used to develop action levels specific to the HWMA/RCRA closure of Tanks WM-184, WM-185, and WM-186. Action levels were developed by defining the acceptable excess cancer risk and hazard quotient thresholds and calculating corresponding action levels based upon these risk and hazard thresholds. Finally, the excess cancer risk and hazard for all pathways and contaminants at the developed action levels are presented. The technique for calculation of action levels described in this appendix will be applied to any additional COCs identified during the course of closure activities for Tanks WM-184, WM-185, and WM-186.

This analysis considers two pathways: soil inhalation and soil ingestion to an occupational receptor. Performing the analysis considering these pathways is very conservative. Environmental Protection Agency (EPA) guidance (EPA 1989) states that the soil inhalation and soil ingestion pathways are appropriate for soil contamination not greater than 10 feet in depth. While the potential soil contamination resulting from liquid contacting the internal tank surfaces will be greater than 40 feet in depth, these pathways were retained to ensure the protectiveness of the action level development methodology. In developing the conceptual site model for this risk assessment, the following assumptions were made:

1. Liquid infiltration contacts the internal tank surfaces

2. Contacting liquid then exits the tank system with all COCs present at action level concentrations

3. Each liter of contaminated liquid contaminates 1 kg of soil (thus each part per million of contaminant in the liquid is equivalent to one part per million of contaminant in the soil).

Assumption No. 1 is conservative due to the planned grouting of the tank system. Once the tanks have been grouted, it is highly unlikely that water infiltration will contact the internal tank surfaces. Assumption No. 2 is conservative because it assumes immediate release of liquid contacting the internal tank surfaces from the tank to the soil (should such liquid/tank surface contact be possible, which is unlikely due to grouting). In reality, liquid contacting the internal tank surfaces will remain contained within the stainless steel tanks and concrete vaults. Assumption No. 3 is conservative for three reasons. First, assuming an average bulk soil density of 1.3 kg/L, and an average soil porosity of 0.45, the void volume in a typical kilogram of soil is approximately 350 mL. Thus, although the assumption has been made that each liter of contaminated liquid contaminates 1 kg of soil, in reality, it is only physically possible for 350 mL of the contaminated liquid to contaminate each kilogram of soil. Second, it is assumed that the liquid and soil are in contact for sufficient time to allow mass transfer equilibrium to be reached between the soil column and the liquid, whereas in reality, the water will be flowing through the soil column and equilibrium will not be reached. Finally, it is assumed that 100% of the contaminant is transferred to the soil without regard for partitioning of the contaminant between the soil column and the water. In reality, a fraction of each of the contaminants will remain contained within the contaminated liquid.

## Step 1: Define the Total Allowable Excess Cancer Risk and Hazard Quotient to the Future Occupational Receptor

As stated in the assumptions above, the liquid that may come into contact with the closed tank system and subsequently contaminate surrounding soil is assumed to exit the tank system and enter the surrounding soil at the action level concentration. The surrounding soil is then assumed to be contaminated at equivalent parts per million concentrations. Consequently, risk-based media cleanup standards are appropriate to establish the allowable excess cancer risk and hazard quotient. Protective media cleanup standards for human health means constituent concentrations that result in the total residual risk from a medium to an individual exposed over a lifetime falling within a range from $10^{-4}$ to $10^{-6}$, with a cumulative carcinogenic risk range. For noncarcinogenic effects, EPA generally interprets protective cleanup standards to mean constituent concentration that an individual could be exposed to on a daily basis without appreciable risk of deleterious effect during a lifetime; the hazard index generally should not exceed 1 (55 FR 46, 1990; 55 FR 145, 1990); 61 FR 85, 1996). To ensure protectiveness of human health, the most conservative threshold for excess cancer risk, 1.0E–06, will be used for Tanks WM-184, WM-185, and WM-186. Therefore

- Total allowable risk threshold = 1.0E–06
- Total allowable hazard quotient threshold = 1.0.

## Step 2: Define Receptors and Pathways

The pathways considered for developing action levels include

- Occupational receptor ingestion of contaminated soil
- Occupational receptor inhalation of contaminated soil.

## Step 3: Define Contaminants of Concern and Toxicity Parameters

The contaminant of concern (COC) list was developed by defining all HWMA/RCRA-regulated constituents that meet either of the following criteria:

1. The HWMA/RCRA-regulated constituent was detected during sampling and analysis of the waste currently contained within the tanks ***and*** the constituent is listed in the United States EPA Region 9 Preliminary Remediation Goal (PRG) Table (EPA 2003)[a]
2. The HWMA/RCRA-regulated constituent was determined to be part of the INTEC liquid waste stream as described in *A Regulatory Analysis and Reassessment of U.S. Environmental Protection*

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a. One constituent, 2-hexanone, while not listed in the EPA Region 9 PRG Table, was listed in the EPA Region III Risk-based Concentration Table (EPA 2002). This constituent was retained in the COC list, and toxicity information from the Region III document was used to determine constituent-specific action levels for 2-hexanone.

*Agency Listed Hazardous Waste Number for Applicability to the INTEC Liquid Waste System* (Gilbert and Venneman 1999).

Applying the two criteria defined above allows definition of the complete COC list for HWMA/RCRA closure of Tanks WM-184, WM-185, and WM-186. The complete list of COCs is provided in Table B-1. As stated in criterion No. 1, above, detected constituents that are not listed in the EPA Region 9 PRG Table were excluded from the COC list. Constituents excluded for this reason were calcium, chloride, magnesium, nitrate, phosphate, and sulfate.

Reference doses and slope factors for each of the contaminants of concern are provided in Table B-1. This information was obtained from the United States EPA Region 9 PRG Table (EPA 2003). Toxicity information for 2-hexanone was obtained from the EPA Region III Risk-based Concentration Table (EPA 2002). The EPA Region 9 PRG Table does not include inhalation reference doses for antimony, arsenic, cadmium, and chromium. As requested by the Idaho Department of Environmental Quality (DEQ), the ingestion reference doses for these four metals were used as both ingestion and inhalation reference doses. Toxicity information is available for all COCs listed in Table B-1 with the exception of lead. While there is no specific toxicity information currently available for lead, separate EPA guidance was used to develop the action level for lead (see Step 8).

The COC list for this closure includes Phenol, which was detected during confirmation sampling of Tank WM-182. Phenol was added to the action level list and included in the calculation of action levels.

Table B-1. COCs and toxicity parameters as provided in the EPA Region 9 PRG Table (EPA 2003).

| COC | Oral Slope Factor 1/(mg/kg-d) | Oral Reference Dose (mg/kg-d) | Inhalation Slope Factor 1/(mg/kg-d) | Inhalation Reference Dose (mg/kg-d) |
|---|---|---|---|---|
| 1,1,1-trichloroethane | — | 0.02 | — | 0.29 |
| 2,4-dinitrophenol | — | 0.002 | — | 0.002 |
| 2-hexanone[a] | — | 0.04 | — | 0.0014 |
| Acetone | — | 0.1 | — | 0.1 |
| Aluminum | — | 1 | — | 0.0014 |
| Antimony | — | 0.0004 | — | 0.0004[b] |
| Aroclor-1260 | 2 | — | 2 | — |
| Arsenic | 1.5 | 0.0003 | 15 | 0.0003[b] |
| Barium | — | 0.07 | — | 0.00014 |
| Benzene | 0.055 | 0.003 | 0.027 | 0.0017 |
| Beryllium | — | 0.002 | 8.4 | 0.0000057 |
| Bromomethane | — | 0.0014 | — | 0.0014 |
| Cadmium | — | 0.0005 | 6.3 | 0.0005[b] |
| Carbon disulfide | — | 0.1 | — | 0.2 |
| Carbon tetrachloride | 0.13 | 0.0007 | 0.053 | 0.0007 |
| Chloroethane | 0.0029 | 0.4 | 0.0029 | 2.9 |
| Chloromethane | 0.013 | — | 0.0063 | 0.086 |
| Chromium | — | 0.003 | 290 | 0.003[b] |
| Cobalt | — | 0.06 | — | — |
| Copper | — | 0.037 | — | — |
| Cyclohexane | — | 5.7 | — | 5.7 |
| Cyclohexanone | — | 5 | — | 5 |
| Ethyl acetate | — | 0.9 | — | 0.9 |
| Ethyl benzene | — | 0.1 | — | 0.29 |
| Fluoride | — | 0.06 | — | — |
| Iron | — | 0.3 | — | — |
| Lead | — | — | — | — |
| Manganese | — | 0.024 | — | 0.000014 |
| Mercury | — | 0.0003 | — | 0.000086 |
| Methanol | — | 0.5 | — | 0.5 |
| Methyl ethyl ketone | — | 0.6 | — | 0.29 |
| Methyl isobutyl ketone | — | 0.08 | — | 0.023 |
| Methylene chloride | 0.0075 | 0.06 | 0.0016 | 0.86 |
| Nickel | — | 0.02 | — | — |
| N-nitrosodimethylamine | 51 | — | 49 | — |
| Phenol | — | 0.6 | — | 0.6 |
| Pyridine | — | 0.001 | — | 0.001 |
| Selenium | — | 0.005 | — | — |
| Silver | — | 0.005 | — | — |
| Tetrachloroethylene | 0.052 | 0.01 | 0.002 | 0.11 |
| Thallium | — | 0.000066 | — | — |
| Toluene | — | 0.2 | — | 0.11 |
| Trichloroethylene | 0.011 | 0.006 | 0.006 | 0.006 |
| Vanadium | — | 0.007 | — | — |
| Xylene | — | 2 | — | 0.2 |
| Zinc | — | 0.3 | — | — |

a. The toxicity information was obtained from the EPA Region III Risk-based Concentration Table (EPA 2002).

b. The ingestion reference dose is used as the inhalation reference dose although no inhalation reference dose is provided in the EPA Region 9 PRG Table (EPA 2003).

## Step 4: Define Percentage of Risk and Hazard to be Applied to Ingestion and Inhalation Scenario

The total allowable excess cancer risk and hazard quotient must be split into the fraction that is allowable for the ingestion pathway and the fraction that is allowable for the inhalation pathway. Experience indicates that the ingestion pathway will drive the risk and hazard for the occupational receptor. Consequently, the majority (99.5%) of the allowable risk and hazard defined in Step 1 above was assigned to the ingestion pathway as shown in Table B-2.

Table B-2. Pathway-specific allowable risk and hazard.

| | Total | Ingestion (%) | Inhalation (%) | Ingestion Fraction | Inhalation Fraction |
|---|---|---|---|---|---|
| Risk | 1.00E!06 | 99.5 | 0.5 | 9.95E!07 | 5.00E!09 |
| Hazard quotient | 1.00E+00 | 99.5 | 0.5 | 9.95E!01 | 5.00E!03 |

## Step 5: Calculate the COC-Specific Allowable Risk and Hazard Quotient for Each Pathway

Back calculation of action levels for COCs requires determination of allowable risk for each COC.[b] The sum of all allowable risks must be less than 1.0E–06. To determine the allowable risk for each COC, the total allowable risk must be apportioned among the COCs. There are several techniques for apportioning allowable risk among COCs.

The simplest technique for apportioning allowable risk is to distribute allowable risk equally among the COCs. Using this technique, the allowable risk is divided by the total number of carcinogenic COCs and the result is used as the allowable risk for each COC. The problem with this approach is that it makes no differentiation among COCs with respect to carcinogenic threat to human health. In the case of the action level determination for the HWMA/RCRA closure of Tanks WM-184, WM-185, and WM-186, the same allowable risk is assigned to a COC that is extremely carcinogenic (N-nitrosodimethylamine [slope factor 51 $(mg/kg\text{-}d)^{-1}$]) and a contaminant that is minimally carcinogenic (chloroethane [slope factor 0.0029 $(mg/kg\text{-}d)^{-1}$]). Using this approach results in action levels that are extremely low (below detection levels in many instances) for the highly carcinogenic compounds and action levels that are excessively high for minimally carcinogenic compounds. This approach results in decontamination efforts being driven by the need to meet a single action level for the most carcinogenic component. The actual COC concentrations for the less carcinogenic components will be reduced far below action levels, resulting in a total residual risk far below the threshold of 1.0E!06. While extremely conservative, this approach results in action levels that may prove impossible to achieve during closure (particularly those below detection limits).

A second approach uses slope factor normalization to apportion allowable risk among the COCs. The slope factors for all carcinogenic COCs are summed, and the percent slope factor contribution to the total is used to determine the percent of the allowable risk that is apportioned to each COC. In this way, the majority of the allowable risk is assigned to the COCs that are the most highly carcinogenic. This

b. While this discussion of apportioning risk among COCs is written with respect to determination of action levels using carcinogenic contaminants and risk-based back-calculation, it applies equally to determination of action levels using non-carcinogenic contaminants and hazard-based back-calculation.

technique is superior to the equal distribution technique described above because it results in action levels for highly-carcinogenic contaminants that are above detection limits and realistically achievable, while still maintaining the overall allowable risk below the regulatory threshold. The problem with this approach for the purposes of determining action levels for the closure of Tanks WM-184, WM-185, and WM-186 is the presence of the extremely carcinogenic N-nitrosodimethylamine. This contaminant is extremely carcinogenic with respect to the other COCs present in the tank system. Using the normalization approach, consequently, results in the majority of the allowable risk being assigned to this contaminant. This results in greatly reduced action levels for moderately carcinogenic contaminants such as heavy metals. This approach results in decontamination efforts being driven by the need to meet action levels for the metals. Due to the chemistry associated with the contents of the tanks, and the relative ease of decontaminating organic contaminants versus metals, decontamination to meet the action levels for metals will result in actual concentrations of organic constituents that will be far below the action levels for these constituents. This would result in a total residual risk far below the threshold of 1.0E!06. This approach results in action levels for various metals that may prove impossible to achieve during closure.

While both approaches described above result in action levels that are compliant with the need to reduce risk below 1.0E!06, the first approach results in an impracticable action level for the highly carcinogenic N-nitrosodimethylamine. The second approach results in impracticable action levels for a variety of heavy metals. A compromise approach balancing the action levels for the amine and the metals to achievable, yet protective, levels was developed. This third approach uses logarithmic slope factor normalization to apportion allowable risk among the COCs. A normalizing power of 0.5 was selected via trial and error that resulted in achievable, yet compliant action levels for all COCs. Each of the slope factors was raised to the power of 0.5. These slope factors were then summed, and the percent contribution to this sum of each slope factor was determined. This percent contribution was then used to assign allowable risk to all carcinogenic COCs.

The three approaches above are alternate methods for assigning allowable risk to each COC. The sum of the allowable risk for each approach is the same, at 1.0E!06. Selection of the third technique provides action levels that are technically practicable. The true risk resulting from each COC is calculated in Step 7 of this methodology. This true risk is calculated at 9.2E!07, demonstrating that the selected action levels are compliant with the regulatory threshold of 1.0E!06. The calculation of true residual risk is independent of the apportioning of allowable risk performed in this step.

As discussed above, allowable risk and hazard quotients for each COC for each pathway were normalized logarithmically against their expected percent contribution to the overall risk and hazard for each pathway. For carcinogenic risk, the square root of the slope factor for each COC was determined. The normalized slope factor percentage was determined by dividing the square root of the slope factor for each COC by the sum of the square root of the slope factors for all COCs for a given pathway. This percent contribution was then multiplied by the total pathway-specific allowable risk to calculate the COC- and pathway-specific allowable risk. To increase the conservativeness of the design, correction factors (discussed below) were applied to COCs, as necessary, to reduce the total allowable risk for each COC. The resulting COC pathway-specific allowable risks for ingestion and inhalation are listed in Table B-3.

For non-carcinogenic hazard, the square root of the inverse of the reference dose for each COC was determined. The normalized inverse reference dose percentage was determined by dividing the square root of the inverse reference dose for each COC by the sum of the square root of the inverse reference doses for all COCs for a given pathway. This percent contribution was then multiplied by the total pathway-specific allowable hazard to calculate the COC- and pathway-specific allowable hazard. To increase the conservativeness of the design, correction factors (discussed below) were applied to COCs, as necessary, to reduce the total allowable hazard for each COC. The resulting COC pathway-specific allowable hazard for ingestion and inhalation are listed in Table B-3.

Table B-3. COC-specific allowable risk and hazard for the soil ingestion and inhalation pathways.

| COC | Effective Allowable Ingestion Risk | Effective Allowable Inhalation Risk | Effective Allowable Ingestion Hazard | Effective Allowable Inhalation Hazard |
|---|---|---|---|---|
| 1,1,1-Trichloroethane | — | — | 1.08E!02 | 7.18E!06 |
| 2,4-Dinitrophenol | — | — | 3.43E!02 | 8.65E!05 |
| 2-Hexanone | — | — | 7.67E!03 | 1.03E!04 |
| Acetone | — | — | 4.85E!03 | 1.22E!05 |
| Aluminum | — | — | 1.53E!03 | 1.03E!04 |
| Antimony | — | — | 7.67E!02 | 1.93E!04 |
| Aroclor-1260 | 1.28E!07 | 2.00E!10 | 1.08E!03 | 2.74E!06 |
| Arsenic | 1.11E!07 | 5.47E!10 | 8.85E!02 | 2.23E!04 |
| Barium | — | — | 5.80E!04 | 3.27E!05 |
| Benzene | 3.55E!09 | 3.87E!12 | 4.67E!03 | 1.56E!05 |
| Berylium | — | 4.09E!10 | 3.43E!02 | 1.62E!03 |
| Bromomethane | — | — | 4.10E!02 | 1.03E!04 |
| Cadmium | — | 3.54E!11 | 6.86E!03 | 1.73E!05 |
| Carbon disulfide | — | — | 4.85E!03 | 8.65E!06 |
| Carbon tetrachloride | 6.54E!09 | 6.50E!12 | 1.16E!02 | 2.92E!05 |
| Chloroethane | 4.89E!09 | 7.60E!12 | 2.43E!03 | 2.27E!06 |
| Chloromethane | 1.03E!08 | 1.12E!11 | 0.00E+00 | 1.32E!05 |
| Chromium | — | 2.40E!09 | 2.80E!02 | 7.06E!05 |
| Cobalt | — | — | 6.26E!03 | 0.00E+00 |
| Copper | — | — | 7.97E!03 | 0.00E+00 |
| Cyclohexane | — | — | 6.42E!04 | 1.62E!06 |
| Cyclohexanone | — | — | 6.86E!04 | 1.73E!06 |
| Ethyl Acetate | — | — | 1.62E!03 | 4.08E!06 |
| Ethyl Benzene | — | — | 4.85E!03 | 7.18E!06 |
| Flouride | — | — | 6.26E!03 | 0.00E+00 |
| Iron | — | — | 2.80E!03 | 0.00E+00 |
| Lead | — | — | 0.00E+00 | 0.00E+00 |
| Manganese | — | — | 9.90E!03 | 1.03E!03 |
| Mercury | — | — | 2.53E!04 | 1.19E!06 |
| Methanol | — | — | 2.17E!03 | 5.47E!06 |
| Methyl ethyl ketone | — | — | 1.32E!04 | 4.79E!07 |
| Methyl isobutyl ketone | — | — | 5.42E!03 | 2.55E!05 |
| Methylene chloride | 7.86E!09 | 5.65E!12 | 6.26E!03 | 4.17E!06 |
| Nickel | — | — | 1.08E!02 | 0.00E+00 |
| N-Nitrosodimethylamine | 6.48E!07 | 9.88E!10 | 0.00E+00 | 0.00E+00 |
| Phenol | — | — | 1.98E!03 | 4.99E!06 |
| Pyridine | — | — | 2.11E!03 | 5.32E!06 |
| Selenium | — | — | 8.68E!05 | 0.00E+00 |
| Silver | — | — | 2.89E!04 | 0.00E+00 |
| Tetrachloroethylene | 4.14E!09 | 1.26E!12 | 3.07E!03 | 2.33E!06 |
| Thallium | — | — | 1.89E!01 | 0.00E+00 |
| Toluene | — | — | 3.43E!03 | 1.17E!05 |
| Trichloroethylene | 7.93E!10 | 9.11E!13 | 1.65E!03 | 4.16E!06 |
| Vanadium | — | — | 1.83E!02 | 0.00E+00 |
| Zinc | — | — | 2.80E!03 | 0.00E+00 |
| **Total** | 9.26E!07 | 4.62E!09 | 6.48E!01 | 3.76E!03 |

Correction factors were used in the risk calculations to lower the action levels of contaminants to meet regulatory thresholds. Risk calculations alone would produce concentrations greater than the maximum concentration of contaminants for the toxicity characteristic. Correction factors, therefore, were used to augment the risk number to ensure hazardous waste is not left in place. Removing hazardous waste is the first criteria for achieving clean closure for the tank system.

In an effort to develop action levels at appropriate concentrations and meet project goals for protection of the public and the environment, correction factors were developed on a case-by-case basis and may vary for different tank systems. Systems that are fairly accessible and with contamination that can be removed to low concentrations will have different correction factors than those used for tanks systems that are not easily accessible and where effective decontamination may be more difficult to achieve. Two important points should be recognized:

- Correction factors are not intended to be the same for all closure actions. Therefore, the Department of Energy can develop action levels as conservative as possible on a project basis.

- Action levels will always be protective of human health and the environment based on the calculated risks and hazard index.

The use of correction factors is performed to lower action levels to concentrations below regulatory thresholds while accounting for project-specific challenges to clean closure. The correction factors are not used to adjust for the uncertainty of any closure project. The difference between the use of correction factors and accounting for uncertainty is clearly established by the following explanation.

Using conservative assumptions when calculating the risk and hazard quotient negates uncertainties associated with meeting the performance standard for clean closure. Examples of the conservative assumptions used in action level calculation are listed below:

- Risk and hazard indices are based on the total number of constituents that may be detected in the unit. Actually, some of these constituents (particularly organic compounds) will not be present after waste removal and decontamination. For example N-nitrosodimethylamine is a significant contributor to risk. However, it is likely that this compound will not be detected during final sampling. The total risk will then be reduced by the amount contributed by N-nitrosodimethylamine. The calculated risk for N-nitrosodimethylamine from soil ingestion and inhalation is 6.48E!07. This is the greatest potential risk contributor in Tanks WM-184, WM-185, and WM-186.

- The probability of detecting N-nitrosodimethylamine after decontamination is based on the decontamination factor that is necessary to reduce the maximum detected concentration to one that is below the detection limit. This decontamination factor is approximately 15. While the decontamination factor for reducing the concentration of mercury to below the action level is more than 100. The relationship between the two decontamination factors indicates N-nitrosodimethylamine will likely be completely removed.

## Step 6: Calculate the COC- and Pathway-Specific Action Levels from Allowable Risk and Hazard Calculated in Step 5

The equations used to relate risk, intake factor, and slope factor or reference dose to excess cancer risk or hazard quotient are given in Step 7. These equations were obtained from EPA guidance (EPA 1989). The risk-based COC-specific action levels were calculated from COC-specific allowable risk by dividing the COC-specific allowable risk (Table B-3) by the intake factor coefficient (see Step 7) and the COC-specific slope factor (Table B-1). The hazard-based COC-specific action levels were calculated from COC-specific allowable hazard quotients by dividing the COC-specific allowable hazard quotient (Table B-3) by the intake factor coefficient (see Step 7) and multiplying by the reference dose (Table B-1). The COC-specific action levels for the ingestion and inhalation pathways resulting from COC-specific allowable risk and COC-specific allowable hazard are listed in Table B-4. To be conservative, the minimum pathway-specific action level was used as the overall action level. The final effective action levels are provided in the right-hand column of Table B-4.

Table B-4. Pathway-specific and effective action levels for each COC.

| COC | Action Level (mg/Kg) Ingestion Risk | Action Level (mg/Kg) Inhalation Risk | Action Level (mg/Kg) Ingestion Hazard | Action Level (mg/Kg) Inhalation Hazard | Effective Action Level (mg/Kg) |
|---|---|---|---|---|---|
| 1,1,1-Trichloroethane | — | — | 4.4E+02 | 8.1E+04 | 4.4E+02 |
| 2,4-Dinitrophenol | — | — | 1.4E+02 | 6.7E+03 | 1.4E+02 |
| 2-Hexanone | — | — | 6.3E+02 | 5.6E+03 | 6.3E+02 |
| Acetone | — | — | 9.9E+02 | 4.8E+04 | 9.9E+02 |
| Aluminum | — | — | 3.1E+03 | 5.6E+03 | 3.1E+03 |
| Antimony | — | — | 6.3E+01 | 3.0E+03 | 6.3E+01 |
| Aroclor-1260 | 3.7E!01 | 1.1E+01 | 1.3E+03 | 6.4E+04 | 3.7E!01 |
| Arsenic | 4.2E!01 | 4.0E+00 | 5.4E+01 | 2.6E+03 | 4.2E!01 |
| Barium | — | — | 8.3E+01 | 1.8E+02 | 8.3E+01 |
| Benzene | 3.7E!01 | 1.6E+01 | 2.9E+01 | 1.0E+03 | 3.7E!01 |
| Berylium | — | 5.3E+00 | 1.4E+02 | 3.6E+02 | 5.3E+00 |
| Bromomethane | — | — | 1.2E+02 | 5.6E+03 | 1.2E+02 |
| Cadmium | — | 6.1E!01 | 7.0E+00 | 3.4E+02 | 6.1E!01 |
| Carbon disulfide | — | — | 9.9E+02 | 6.7E+04 | 9.9E+02 |
| Carbon tetrachloride | 2.9E!01 | 1.3E+01 | 1.7E+01 | 8.0E+02 | 2.9E-01 |
| Chloroethane | 9.6E+00 | 2.8E+02 | 2.0E+03 | 2.6E+05 | 9.6E+00 |
| Chloromethane | 4.5E+00 | 1.9E+02 | — | 4.4E+04 | 4.5E+00 |
| Chromium | — | 9.0E!01 | 1.7E+02 | 8.2E+03 | 9.0E!01 |
| Cobalt | — | — | 7.7E+02 | — | 7.7E+02 |
| Copper | — | — | 6.0E+02 | — | 6.0E+02 |
| Cyclohexane | — | — | 7.5E+03 | 3.6E+05 | 7.5E+03 |
| Cyclohexanone | — | — | 7.0E+03 | 3.4E+05 | 7.0E+03 |
| Ethyl Acetate | — | — | 3.0E+03 | 1.4E+05 | 3.0E+03 |
| Ethyl Benzene | — | — | 9.9E+02 | 8.1E+04 | 9.9E+02 |
| Flouride | — | — | 7.7E+02 | — | 7.7E+02 |
| Iron | — | — | 1.7E+03 | — | 1.7E+03 |
| Lead | — | — | — | — | 0.0E+00 |
| Manganese | — | — | 4.9E+02 | 5.6E+02 | 4.9E+02 |
| Mercury | — | — | 1.6E-01 | 4.0E+00 | 1.6E!01 |
| Methanol | — | — | 2.2E+03 | 1.1E+05 | 2.2E+03 |
| Methyl ethyl ketone | — | — | 1.6E+02 | 5.4E+03 | 1.6E+02 |
| Methyl isobutyl ketone | — | — | 8.9E+02 | 2.3E+04 | 8.9E+02 |
| Methylene chloride | 6.0E+00 | 3.8E+02 | 7.7E+02 | 1.4E+05 | 6.0E+00 |
| Nickel | — | — | 4.4E+02 | — | 4.4E+02 |
| N-Nitrosodimethylamine | 7.3E!02 | 2.2E+00 | — | — | 7.3E!02 |
| Phenol | — | — | 2.4E+03 | 1.2E+05 | 2.4E+03 |
| Pyridine | — | — | 4.3E+00 | 2.1E+02 | 4.3E+00 |
| Selenium | — | — | 8.9E-01 | — | 8.9E!01 |
| Silver | — | — | 3.0E+00 | — | 3.0E+00 |
| Tetrachloroethylene | 4.5E!01 | 6.9E+01 | 6.3E+01 | 1.0E+04 | 4.5E!01 |
| Thallium | — | — | 2.5E+01 | — | 2.5E+01 |
| Toluene | — | — | 1.4E+03 | 5.0E+04 | 1.4E+03 |
| Trichloroethylene | 4.1E!01 | 1.7E+01 | 2.0E+01 | 9.7E+02 | 4.1E!01 |
| Vanadium | — | — | 2.6E+02 | — | 2.6E+02 |
| Zinc | — | — | 1.7E+03 | — | 1.7E+03 |

a. The action level for lead cannot be determined using a risk-based approach, as there are currently no established toxicity parameters for lead. The action level for lead was developed as described in Step 8.

## Step 7: Determine the True Excess Cancer Risk and Hazard Quotient Resulting in the Action Levels Calculated in Step 7

Soil concentrations resulting from the calculated action levels were used as a starting point to assess the risk and hazard to the occupational receptor via the soil ingestion and inhalation pathways. The results of this analysis are provided in Table B-5 below. The table also includes the cumulative risk and hazard posed by both pathways. The calculation spreadsheets are shown on the following pages in Equations (B-1) through (B-9) and Tables B-6 through B-9.

Table B-5. Cumulative excess cancer risk resulting from soil ingestion and soil inhalation pathways to an occupational receptor from contaminated soil at the effective action levels presented in Table B-4.

| COC | Risk (Ingestion Pathway) | Risk (Inhalation Pathway) | Total Risk | Hazard Quotient (Ingestion Pathway) | Hazard Quotient (Inhalation Pathway) | Total Hazard Quotient |
|---|---|---|---|---|---|---|
| 1,1,1-Trichloroethane | — | — | — | 1.08E!02 | 3.93E!08 | 1.08E!02 |
| 2,4-Dinitrophenol | — | — | — | 3.43E!02 | 1.80E!06 | 3.43E!02 |
| 2-Hexanone | — | — | — | — | — | — |
| Acetone | — | — | — | 4.85E!03 | 2.55E!07 | 4.85E!03 |
| Aluminum | — | — | — | 1.53E!03 | 5.76E!05 | 1.59E!03 |
| Antimony | — | — | — | 7.67E!02 | 4.03E!06 | 7.67E!02 |
| Aroclor-1260 | 1.28E!07 | 6.75E!12 | 1.28E!07 | — | 1.77E!09 | 1.77E!09 |
| Arsenic | 1.11E!07 | 5.84E!11 | 1.11E!07 | 6.90E!04 | 3.63E!08 | 6.90E!04 |
| Barium | — | — | — | 5.80E!04 | 1.52E!05 | 5.95E!04 |
| Benzene | 3.55E!09 | 9.16E!14 | 3.55E!09 | 6.01E!05 | 5.57E!09 | 6.01E!05 |
| Berylium | — | 4.09E!10 | 4.09E!10 | 1.29E!03 | 2.39E!05 | 1.32E!03 |
| Bromomethane | — | — | — | 4.10E!02 | 2.16E!06 | 4.10E!02 |
| Cadmium | — | 3.54E!11 | 3.54E!11 | 5.98E!04 | 3.14E!08 | 5.98E!04 |
| Carbon disulfide | — | — | — | 4.85E!03 | 1.28E!07 | 4.85E!03 |
| Carbon tetrachloride | 6.54E!09 | 1.40E!13 | 6.55E!09 | 2.01E!04 | 1.06E!08 | 2.01E!04 |
| Chloroethane | 4.89E!09 | 2.57E!13 | 4.89E!09 | 1.18E!05 | 8.53E!11 | 1.18E!05 |
| Chloromethane | 1.03E!08 | 2.64E!13 | 1.03E!08 | — | 1.36E!09 | 1.36E!09 |
| Chromium | — | 2.40E!09 | 2.40E!09 | 1.47E!04 | 7.72E!09 | 1.47E!04 |
| Cobalt | — | — | — | 6.26E!03 | — | 6.26E!03 |
| Copper | — | — | — | 7.97E!03 | — | 7.97E!03 |
| Cyclohexane | — | — | — | 6.42E!04 | 3.38E!08 | 6.42E!04 |
| Cyclohexanone | — | — | — | 6.86E!04 | 3.61E!08 | 6.86E!04 |
| Ethyl Acetate | — | — | — | 1.62E!03 | 8.50E!08 | 1.62E!03 |
| Ethyl Benzene | — | — | — | 4.85E!03 | 8.79E!08 | 4.85E!03 |
| Flouride | — | — | — | 6.26E!03 | — | 6.26E!03 |
| Iron | — | — | — | 2.80E!03 | — | 2.80E!03 |
| Lead | — | — | — | — | — | — |
| Manganese | — | — | — | 9.90E!03 | 8.92E!04 | 1.08E!02 |
| Mercury | — | — | — | 2.53E!04 | 4.64E!08 | 2.53E!04 |
| Methanol | — | — | — | 2.17E!03 | 1.14E!07 | 2.17E!03 |
| Methyl ethyl ketone | — | — | — | 1.32E!04 | 1.44E!08 | 1.32E!04 |
| Methyl isobutyl ketone | — | — | — | 5.42E!03 | 9.92E!07 | 5.42E!03 |
| Methylene chloride | 7.86E!09 | 8.82E!14 | 7.86E!09 | 4.88E!05 | 1.79E!10 | 4.88E!05 |
| Nickel | — | — | — | 1.08E!02 | — | 1.08E!02 |
| N-Nitrosodimethylamine | 6.48E!07 | 3.27E!11 | 6.48E!07 | — | — | — |
| Phenol | — | — | — | 1.98E!03 | 1.04E!07 | 1.98E!03 |
| Pyridine | — | — | — | 2.11E!03 | 1.11E!07 | 2.11E!03 |
| Selenium | — | — | — | 8.68E!05 | — | 8.68E!05 |
| Silver | — | — | — | 2.89E!04 | — | 2.89E!04 |
| Tetrachloroethylene | 4.14E!09 | 8.37E!15 | 4.14E!09 | 2.22E!05 | 1.06E!10 | 2.22E!05 |
| Thallium | — | — | — | 1.89E!01 | — | 1.89E!01 |
| Toluene | — | — | — | 3.43E!03 | 3.28E!07 | 3.43E!03 |
| Trichloroethylene | 7.93E!10 | 2.28E!14 | 7.93E!10 | 3.36E!05 | 1.77E!09 | 3.36E!05 |
| Vanadium | — | — | — | 1.83E!02 | — | 1.83E!02 |
| Zinc | — | — | — | 2.80E!03 | — | 2.80E!03 |
| **Total** | 9.26E!07 | 2.95E!09 | 9.29E!07 | 4.55E!01 | 1.00E!03 | 4.56E!01 |

## Occupational Soil Ingestion

$$Intake\ Factor = \left(\frac{C \times FI \times EF \times CF}{AT}\right) \times \left(\frac{IR \times ED}{BW}\right) \qquad \text{(B-1)}$$

where

| | | |
|---|---|---|
| $C$ | = | contaminant concentration (mg/kg) (contaminant dependent) |
| $FI$ | = | fraction ingested from source = 1 |
| $EF$ | = | exposure frequency (day/year) = 250 |
| $CF$ | = | conversion factor (kg/mg) = 1.00E!06 |
| $AT$ | = | averaging time (day) = 2.55E+04 |
| $IR$ | = | ingestion rate (mg/day) = 50 |
| $ED$ | = | exposure duration (year) = 25 |
| $BW$ | = | body weight (kg) = 70 |

**Assumption: Each liter of leachate contaminates 1 kg of soil.**

$$Risk = Intake\ Factor \times Slope\ Factor \qquad \text{(B-2)}$$

Table B-6. Calculation of excess cancer risk for an occupational soil ingestion scenario using the action levels provided in Table B-4.

| Constituent | C (mg/Kg) | Intake Factor/C (1/day) | Intake Factor (mg/Kg-day) | Slope Factor (Kg-day/mg) | Risk | Risk Percentage |
|---|---|---|---|---|---|---|
| 1,1,1-Trichloroethane | 4.44E+02 | 1.75E!07 | 7.77E!05 | 0.00E+00 | — | — |
| 2,4-Dinitrophenol | 1.40E+02 | 1.75E!07 | 2.46E!05 | 0.00E+00 | — | — |
| 2-Hexanone | 6.27E+02 | 1.75E!07 | 1.10E!04 | 0.00E+00 | — | — |
| Acetone | 9.92E+02 | 1.75E!07 | 1.74E!04 | 0.00E+00 | — | — |
| Aluminum | 3.14E+03 | 1.75E!07 | 5.49E!04 | 0.00E+00 | — | — |
| Antimony | 6.27E+01 | 1.75E!07 | 1.10E!05 | 0.00E+00 | — | — |
| Aroclor-1260 | 3.67E!01 | 1.75E!07 | 6.42E!08 | 2.00E+00 | 1.28E!07 | 13.86% |
| Arsenic | 4.23E!01 | 1.75E!07 | 7.41E!08 | 1.50E+00 | 1.11E!07 | 12.01% |
| Barium | 8.30E+01 | 1.75E!07 | 1.45E!05 | 0.00E+00 | — | — |
| Benzene | 3.68E!01 | 1.75E!07 | 6.45E!08 | 5.50E!02 | 3.55E!09 | 0.38% |
| Berylium | 5.29E+00 | 1.75E!07 | 9.26E!07 | 0.00E+00 | — | — |
| Bromomethane | 1.17E+02 | 1.75E!07 | 2.05E!05 | 0.00E+00 | — | — |
| Cadmium | 6.11E!01 | 1.75E!07 | 1.07E!07 | 0.00E+00 | — | — |
| Carbon disulfide | 9.92E+02 | 1.75E!07 | 1.74E!04 | 0.00E+00 | — | — |
| Carbon tetrachloride | 2.88E!01 | 1.75E!07 | 5.03E!08 | 1.30E!01 | 6.54E!09 | 0.71% |
| Chloroethane | 9.63E+00 | 1.75E!07 | 1.69E!06 | 2.90E!03 | 4.89E!09 | 0.53% |
| Chloromethane | 4.55E+00 | 1.75E!07 | 7.96E!07 | 1.30E!02 | 1.03E!08 | 1.12% |
| Chromium | 9.01E!01 | 1.75E!07 | 1.58E!07 | 0.00E+00 | — | — |
| Cobalt | 7.68E+02 | 1.75E!07 | 1.35E!04 | 0.00E+00 | — | — |
| Copper | 6.03E+02 | 1.75E!07 | 1.06E!04 | 0.00E+00 | — | — |
| Cyclohexane | 7.49E+03 | 1.75E!07 | 1.31E!03 | 0.00E+00 | — | — |
| Cyclohexanone | 7.01E+03 | 1.75E!07 | 1.23E!03 | 0.00E+00 | — | — |
| Ethyl Acetate | 2.98E+03 | 1.75E!07 | 5.21E!04 | 0.00E+00 | — | — |
| Ethyl Benzene | 9.92E+02 | 1.75E!07 | 1.74E!04 | 0.00E+00 | — | — |
| Flouride | 7.68E+02 | 1.75E!07 | 1.35E!04 | 0.00E+00 | — | — |
| Iron | 1.72E+03 | 1.75E!07 | 3.01E!04 | 0.00E+00 | — | — |
| Lead | 0.00E+00 | 1.75E!07 | 0.00E+00 | 0.00E+00 | — | — |
| Manganese | 4.86E+02 | 1.75E!07 | 8.51E!05 | 0.00E+00 | — | — |
| Mercury | 1.55E!01 | 1.75E!07 | 2.72E!08 | 0.00E+00 | — | — |
| Methanol | 2.22E+03 | 1.75E!07 | 3.88E!04 | 0.00E+00 | — | — |
| Methyl ethyl ketone | 1.62E+02 | 1.75E!07 | 2.84E!05 | 0.00E+00 | — | — |
| Methyl isobutyl ketone | 8.87E+02 | 1.75E!07 | 1.55E!04 | 0.00E+00 | — | — |
| Methylene chloride | 5.99E+00 | 1.75E!07 | 1.05E!06 | 7.50E!03 | 7.86E!09 | 0.85% |
| Nickel | 4.44E+02 | 1.75E!07 | 7.77E!05 | 0.00E+00 | — | — |
| N-Nitrosodimethylamine | 7.26E!02 | 1.75E!07 | 1.27E!08 | 5.10E+01 | 6.48E!07 | 70.01% |
| Phenol | 2.43E+03 | 1.75E!07 | 4.25E!04 | 0.00E+00 | — | — |
| Pyridine | 4.31E+00 | 1.75E!07 | 7.55E!07 | 0.00E+00 | — | — |
| Selenium | 8.87E!01 | 1.75E!07 | 1.55E!07 | 0.00E+00 | — | — |
| Silver | 2.96E+00 | 1.75E!07 | 5.18E!07 | 0.00E+00 | — | — |
| Tetrachloroethylene | 4.55E!01 | 1.75E!07 | 7.96E!08 | 5.20E!02 | 4.14E!09 | 0.45% |
| Thallium | 2.55E+01 | 1.75E!07 | 4.46E!06 | 0.00E+00 | — | — |
| Toluene | 1.40E+03 | 1.75E!07 | 2.46E!04 | 0.00E+00 | — | — |
| Trichloroethylene | 4.12E!01 | 1.75E!07 | 7.21E!08 | 1.10E!02 | 7.93E!10 | 0.09% |
| Vanadium | 2.62E+02 | 1.75E!07 | 4.59E!05 | 0.00E+00 | — | — |
| Zinc | 1.72E+03 | 1.75E!07 | 3.01E!04 | 0.00E+00 | — | — |
| | | | | **Total** | 9.26E!07 | 100.00% |

## Occupational Soil Inhalation

$$Intake\ Factor = \left(\frac{C \times IR \times EF \times ET \times ED}{BW \times AT \times PEF}\right) \quad \text{(B-3)}$$

where

| | | |
|---|---|---|
| $C$ | = | soil contaminant concentration (mg/kg) (contaminant dependent) |
| $IR$ | = | inhalation rate ($m^3$/hr) = 0.83 |
| $EF$ | = | exposure frequency (day/year) = 250 |
| $ET$ | = | exposure time (hour/day) = 8 |
| $ED$ | = | exposure duration (year) = 25 |
| $BW$ | = | body weight (kg) = 70 |
| $AT$ | = | averaging time (day) = 2.55E+04 |
| $PEF$ | = | particulate emission factor ($m^3$/kg) (calculated) |

$$PEF = \frac{LS \times 5.8\mathrm{E}+10}{A}\left(\frac{m^4}{kg}\right) \quad \text{(B-4)}$$

where

| | | |
|---|---|---|
| $LS$ | = | prevailing wind field dimension (m) = 49.65 |
| $A$ | = | area of contamination ($m^2$) = 1140.15 |

**Assumption: Each liter of leachate contaminates 1 kg of soil.**

$$Risk = Intake\ Factor \times Slope\ Factor \quad \text{(B-5)}$$

Table B-7. Calculation of excess cancer risk for an occupational soil inhalation scenario using the action levels provided in Table B-4.

| Constituent | C (mg/Kg) | Intake Factor/C (1/day) | Intake Factor (mg/Kg-day) | Slope Factor (Kg-day/mg) | Risk | Risk Percentage |
|---|---|---|---|---|---|---|
| 1,1,1-Trichloroethane | 4.44E+02 | 9.21E-12 | 4.08E-09 | 0.00E+00 | — | — |
| 2,4-Dinitrophenol | 1.40E+02 | 9.21E-12 | 1.29E-09 | 0.00E+00 | — | — |
| 2-Hexanone | 6.27E+02 | 9.21E-12 | 5.77E-09 | 0.00E+00 | — | — |
| Acetone | 9.92E+02 | 9.21E-12 | 9.13E-09 | 0.00E+00 | — | — |
| Aluminum | 3.14E+03 | 9.21E-12 | 2.89E-08 | 0.00E+00 | — | — |
| Antimony | 6.27E+01 | 9.21E-12 | 5.77E-10 | 0.00E+00 | — | — |
| Aroclor-1260 | 3.67E-01 | 9.21E-12 | 3.37E-12 | 2.00E+00 | 6.75E-12 | 0.23% |
| Arsenic | 4.23E-01 | 9.21E-12 | 3.90E-12 | 1.50E+01 | 5.84E-11 | 1.98% |
| Barium | 8.30E+01 | 9.21E-12 | 7.64E-10 | 0.00E+00 | — | — |
| Benzene | 3.68E-01 | 9.21E-12 | 3.39E-12 | 2.70E-02 | 9.16E-14 | 0.00% |
| Berylium | 5.29E+00 | 9.21E-12 | 4.87E-11 | 8.40E+00 | 4.09E-10 | 13.88% |
| Bromomethane | 1.17E+02 | 9.21E-12 | 1.08E-09 | 0.00E+00 | — | — |
| Cadmium | 6.11E-01 | 9.21E-12 | 5.62E-12 | 6.30E+00 | 3.54E-11 | 1.20% |
| Carbon disulfide | 9.92E+02 | 9.21E-12 | 9.13E-09 | 0.00E+00 | — | — |
| Carbon tetrachloride | 2.88E-01 | 9.21E-12 | 2.65E-12 | 5.30E-02 | 1.40E-13 | 0.00% |
| Chloroethane | 9.63E+00 | 9.21E-12 | 8.86E-11 | 2.90E-03 | 2.57E-13 | 0.01% |
| Chloromethane | 4.55E+00 | 9.21E-12 | 4.19E-11 | 6.30E-03 | 2.64E-13 | 0.01% |
| Chromium | 9.01E-01 | 9.21E-12 | 8.29E-12 | 2.90E+02 | 2.40E-09 | 81.56% |
| Cobalt | 7.68E+02 | 9.21E-12 | 7.07E-09 | 0.00E+00 | — | — |
| Copper | 6.03E+02 | 9.21E-12 | 5.55E-09 | 0.00E+00 | — | — |
| Cyclohexane | 7.49E+03 | 9.21E-12 | 6.89E-08 | 0.00E+00 | — | — |
| Cyclohexanone | 7.01E+03 | 9.21E-12 | 6.46E-08 | 0.00E+00 | — | — |
| Ethyl Acetate | 2.98E+03 | 9.21E-12 | 2.74E-08 | 0.00E+00 | — | — |
| Ethyl Benzene | 9.92E+02 | 9.21E-12 | 9.13E-09 | 0.00E+00 | — | — |
| Flouride | 7.68E+02 | 9.21E-12 | 7.07E-09 | 0.00E+00 | — | — |
| Iron | 1.72E+03 | 9.21E-12 | 1.58E-08 | 0.00E+00 | — | — |
| Lead | 0.00E+00 | 9.21E-12 | 0.00E+00 | 0.00E+00 | — | — |
| Manganese | 4.86E+02 | 9.21E-12 | 4.47E-09 | 0.00E+00 | — | — |
| Mercury | 1.55E-01 | 9.21E-12 | 1.43E-12 | 0.00E+00 | — | — |
| Methanol | 2.22E+03 | 9.21E-12 | 2.04E-08 | 0.00E+00 | — | — |
| Methyl ethyl ketone | 1.62E+02 | 9.21E-12 | 1.49E-09 | 0.00E+00 | — | — |
| Methyl isobutyl ketone | 8.87E+02 | 9.21E-12 | 8.17E-09 | 0.00E+00 | — | — |
| Methylene chloride | 5.99E+00 | 9.21E-12 | 5.51E-11 | 1.60E-03 | 8.82E-14 | 0.00% |
| Nickel | 4.44E+02 | 9.21E-12 | 4.08E-09 | 0.00E+00 | — | — |
| N-Nitrosodimethylamine | 7.26E-02 | 9.21E-12 | 6.68E-13 | 4.90E+01 | 3.27E-11 | 1.11% |
| Phenol | 2.43E+03 | 9.21E-12 | 2.24E-08 | 0.00E+00 | — | — |
| Pyridine | 4.31E+00 | 9.21E-12 | 3.97E-11 | 0.00E+00 | — | — |
| Selenium | 8.87E-01 | 9.21E-12 | 8.17E-12 | 0.00E+00 | — | — |
| Silver | 2.96E+00 | 9.21E-12 | 2.72E-11 | 0.00E+00 | — | — |
| Tetrachloroethylene | 4.55E-01 | 9.21E-12 | 4.19E-12 | 2.00E-03 | 8.37E-15 | 0.00% |
| Thallium | 2.55E+01 | 9.21E-12 | 2.35E-10 | 0.00E+00 | — | — |
| Toluene | 1.40E+03 | 9.21E-12 | 1.29E-08 | 0.00E+00 | — | — |
| Trichloroethylene | 4.12E-01 | 9.21E-12 | 3.79E-12 | 6.00E-03 | 2.28E-14 | 0.00% |
| Vanadium | 2.62E+02 | 9.21E-12 | 2.42E-09 | 0.00E+00 | — | — |
| Zinc | 1.72E+03 | 9.21E-12 | 1.58E-08 | 0.00E+00 | — | — |
| | | | | **Total** | 2.95E-09 | 100.00% |

## Occupational Soil Ingestion

$$Intake\ Factor = \left(\frac{C \times FI \times EF \times CF}{AT}\right) \times \left(\frac{IR \times ED}{BW}\right) \quad \text{(B-6)}$$

where

| | | |
|---|---|---|
| *C* | = | contaminant concentration (mg/kg) (contaminant dependent) |
| *FI* | = | fraction ingested from source = 1 |
| *EF* | = | exposure frequency (day/year) = 250 |
| *CF* | = | conversion factor (kg/mg) = 1.00E!06 |
| *AT* | = | averaging time (day) = 9.13E+03 |
| *IR* | = | ingestion rate (mg/day) = 50 |
| *ED* | = | exposure duration (year) = 25 |
| *BW* | = | body weight (kg) = 70 |

**Assumption: Each liter of leachate contaminates 1 kg of soil.**

*Hazard = Intake Factor/Reference Dose* (B-7)

Table B-8. Calculation of hazard quotient for an occupational soil ingestion scenario using the action levels provided in Table B-4.

| Constituent | C (mg/kg) | Intake Factor/C (1/day) | Intake Factor (mg/kg/day) | Reference Dose (mg/kg/day) | Hazard Quotient | Hazard Quotient (%) |
|---|---|---|---|---|---|---|
| 1,1,1-trichloroethane | 4.445E+02 | 4.890E!07 | 2.173E!04 | 2.000E!02 | 1.087E!02 | 2.35 |
| 2,4-dinitrophenol | 1.406E+02 | 4.890E!07 | 6.873E!05 | 2.000E!03 | 3.436E!02 | 7.42 |
| 2-hexanone | 6.286E+02 | 4.890E!07 | 3.074E!04 | 4.000E!02 | 7.684E!03 | 1.66 |
| Acetone | 9.939E+02 | 4.890E!07 | 4.860E!04 | 1.000E!01 | 4.860E!03 | 1.05 |
| Aluminum | 3.143E+03 | 4.890E!07 | 1.537E!03 | 1.000E+00 | 1.537E!03 | 0.33 |
| Antimony | 6.286E+01 | 4.890E!07 | 3.074E!05 | 4.000E!04 | 7.684E!02 | 16.59 |
| Aroclor-1260 | 3.67E-01 | 4.890E!07 | 8.417E!04 | 0.000E+00 | — | — |
| Arsenic | 4.860E!01 | 4.890E!07 | 2.376E!07 | 3.000E!04 | 7.921E!04 | 0.17 |
| Barium | 8.315E+01 | 4.890E!07 | 4.066E!05 | 7.000E!02 | 5.808E!04 | 0.13 |
| Benzene | 4.230E!01 | 4.890E!07 | 2.068E!07 | 3.000E!03 | 6.894E!05 | 0.01 |
| Beryllium | 5.512E+00 | 4.890E!07 | 2.695E!06 | 2.000E!03 | 1.348E!03 | 0.29 |
| Bromomethane | 1.176E+02 | 4.890E!07 | 5.750E!05 | 1.400E!03 | 4.107E!02 | 8.87 |
| Cadmium | 6.365E!01 | 4.890E!07 | 3.112E!07 | 5.000E!04 | 6.224E!04 | 0.13 |
| Carbon disulfide | 9.939E+02 | 4.890E!07 | 4.860E!04 | 1.000E!01 | 4.860E!03 | 1.05 |
| Carbon tetrachloride | 3.302E!01 | 4.890E!07 | 1.614E!07 | 7.000E!04 | 2.306E!04 | 0.05 |
| Chloroethane | 1.105E+01 | 4.890E!07 | 5.404E!06 | 4.000E!01 | 1.351E!05 | 0.00 |
| Chloromethane | 5.220E+00 | 4.890E!07 | 2.553E!06 | 0.000E+00 | — | — |
| Chromium | 9.381E!01 | 4.890E!07 | 4.587E!07 | 3.000E!03 | 1.529E!04 | 0.03 |
| Cobalt | 7.699E+02 | 4.890E!07 | 3.764E!04 | 6.000E!02 | 6.274E!03 | 1.35 |
| Copper | 6.045E+02 | 4.890E!07 | 2.956E!04 | 3.700E!02 | 7.989E!03 | 1.72 |
| Cyclohexane | 7.504E+03 | 4.890E!07 | 3.669E!03 | 5.700E+00 | 6.437E!04 | 0.14 |
| Cyclohexanone | 7.028E+03 | 4.890E!07 | 3.436E!03 | 5.000E+00 | 6.873E!04 | 0.15 |
| Ethyl acetate | 2.982E+03 | 4.890E!07 | 1.458E!03 | 9.000E!01 | 1.620E!03 | 0.35 |
| Ethyl benzene | 9.939E+02 | 4.890E!07 | 4.860E!04 | 1.000E!01 | 4.860E!03 | 1.05 |
| Fluoride | 7.699E+02 | 4.890E!07 | 3.764E!04 | 6.000E!02 | 6.274E!03 | 1.35 |
| Iron | 1.721E+03 | 4.890E!07 | 8.417E!04 | 3.000E!01 | 2.806E!03 | 0.61 |
| Lead | 0.000E+00 | 4.890E!07 | 0.000E+00 | 0.000E+00 | — | — |
| Manganese | 4.869E+02 | 4.890E!07 | 2.381E!04 | 2.400E!02 | 9.920E!03 | 2.14 |
| Mercury | 1.555E!01 | 4.890E!07 | 7.605E!08 | 3.000E!04 | 2.535E!04 | 0.05 |
| Methanol | 2.222E+03 | 4.890E!07 | 1.087E!03 | 5.000E!01 | 2.173E!03 | 0.47 |
| Methyl ethyl ketone | 1.623E+02 | 4.890E!07 | 7.936E!05 | 6.000E!01 | 1.323E!04 | 0.03 |
| Methyl isobutyl ketone | 8.889E+02 | 4.890E!07 | 4.347E!04 | 8.000E!02 | 5.433E!03 | 1.17 |
| Methylene chloride | 6.873E+00 | 4.890E!07 | 3.361E!06 | 6.000E!02 | 5.601E!05 | 0.01 |
| Nickel | 4.445E+02 | 4.890E!07 | 2.173E!04 | 2.000E!02 | 1.087E!02 | 2.35 |
| N-nitrosodimethylamine | 8.335E!02 | 4.890E!07 | 4.075E!08 | 0.000E+00 | — | — |
| Phenol | 2.43E+03 | 4.890E-07 | 1.19E-03 | 6.00E-01 | 1.98E-03 | 0.43 |
| Pyridine | 4.321E+00 | 4.890E!07 | 2.113E!06 | 1.000E!03 | 2.113E!03 | 0.46 |
| Selenium | 8.889E!01 | 4.890E!07 | 4.347E!07 | 5.000E!03 | 8.693E!05 | 0.02 |
| Silver | 2.963E+00 | 4.890E!07 | 1.449E!06 | 5.000E!03 | 2.898E!04 | 0.06 |
| Tetrachloroethylene | 5.220E!01 | 4.890E!07 | 2.553E!07 | 1.000E!02 | 2.553E!05 | 0.01 |
| Thallium | 2.553E+01 | 4.890E!07 | 1.248E!05 | 6.600E!05 | 1.892E!01 | 40.83 |
| Toluene | 1.406E+03 | 4.890E!07 | 6.873E!04 | 2.000E!01 | 3.436E!03 | 0.74 |
| Trichloroethylene | 4.729E!01 | 4.890E!07 | 2.312E!07 | 6.000E!03 | 3.854E!05 | 0.01 |
| Vanadium | 2.630E+02 | 4.890E!07 | 1.286E!04 | 7.000E!03 | 1.837E!02 | 3.96 |
| Xylene | 4.445E+03 | 4.890E!07 | 2.173E!03 | 2.000E+00 | 1.087E!03 | 0.23 |
| Zinc | 1.721E+03 | 4.890E!07 | 8.417E!04 | 3.000E!01 | 2.806E!03 | 0.61 |
| **Total** | | | | | **4.63E!01** | **100.00** |

# Occupational Soil Inhalation

$$Intake\ Factor = \left( \frac{C \times IR \times EF \times ET \times ED}{BW \times AT \times PEF} \right) \qquad \text{(B-8)}$$

where

| | | |
|---|---|---|
| $C$ | = | soil contaminant concentration (mg/kg) (contaminant dependent) |
| $IR$ | = | inhalation rate ($m^3$/hr) = 0.83 |
| $EF$ | = | exposure frequency (day/year) = 250 |
| $ET$ | = | exposure time (hour/day) = 8 |
| $ED$ | = | exposure duration (year) = 25 |
| $BW$ | = | body weight (kg) = 70 |
| $AT$ | = | averaging time (day) = 9.13E+03 |
| $PEF$ | = | particulate emission factor ($m^3$/kg) (calculated) |

$$PEF = \frac{LS \times 5.8\text{E}+10}{A} \left( \frac{m^4}{kg} \right)$$

where

| | | |
|---|---|---|
| $LS$ | = | prevailing wind field dimension (m) = 49.65 |
| $A$ | = | area of contamination ($m^2$) = 1140.15 |

**Assumption: Each liter of leachate contaminates 1 kg of soil.**

$$Hazard = Intake\ Factor/Reference\ Dose \qquad \text{(B-9)}$$

Table B-9. Calculation of hazard quotient for an occupational soil inhalation scenario using the action levels provided in Table B-4.

| Constituent | C (mg/kg) | Intake Factor/C (1/day) | Intake Factor (mg/kg-day) | Reference Dose (mg/kg/day) | Hazard Quotient | Hazard Quotient (%) |
|---|---|---|---|---|---|---|
| 1,1,1-trichloroethane | 4.445E+02 | 2.571E!11 | 1.143E!08 | 2.900E!01 | 3.940E!08 | 0.00 |
| 2,4-dinitrophenol | 1.406E+02 | 2.571E!11 | 3.614E!09 | 2.000E!03 | 1.807E!06 | 0.18 |
| 2-hexanone | 6.286E+02 | 2.571E!11 | 1.616E!08 | 1.400E!03 | 1.154E!05 | 1.14 |
| Acetone | 9.939E+02 | 2.571E!11 | 2.555E!08 | 1.000E!01 | 2.555E!07 | 0.03 |
| Aluminum | 3.143E+03 | 2.571E!11 | 8.080E!08 | 1.400E!03 | 5.772E!05 | 5.69 |
| Antimony | 6.286E+01 | 2.571E!11 | 1.616E!09 | 4.000E!04 | 4.040E!06 | 0.40 |
| Aroclor-1260 | 3.67E-01 | 2.571E!11 | 4.426E!08 | 0.000E+00 | — | — |
| Arsenic | 4.860E!01 | 2.571E!11 | 1.249E!11 | 3.000E!04 | 4.165E!08 | 0.00 |
| Barium | 8.315E+01 | 2.571E!11 | 2.138E!09 | 1.400E!04 | 1.527E!05 | 1.51 |
| Benzene | 4.230E!01 | 2.571E!11 | 1.088E!11 | 1.700E!03 | 6.397E!09 | 0.00 |
| Beryllium | 5.512E+00 | 2.571E!11 | 1.417E!10 | 5.700E!06 | 2.486E!05 | 2.45 |
| Bromomethane | 1.176E+02 | 2.571E!11 | 3.023E!09 | 1.400E!03 | 2.160E!06 | 0.21 |
| Cadmium | 6.365E!01 | 2.571E!11 | 1.636E!11 | 5.000E!04 | 3.273E!08 | 0.00 |
| Carbon disulfide | 9.939E+02 | 2.571E!11 | 2.555E!08 | 2.000E!01 | 1.278E!07 | 0.01 |
| Carbon tetrachloride | 3.302E!01 | 2.571E!11 | 8.488E!12 | 7.000E!04 | 1.213E!08 | 0.00 |
| Chloroethane | 1.105E+01 | 2.571E!11 | 2.842E!10 | 2.900E+00 | 9.799E!11 | 0.00 |
| Chloromethane | 5.220E+00 | 2.571E!11 | 1.342E!10 | 8.600E!02 | 1.561E!09 | 0.00 |
| Chromium | 9.381E!01 | 2.571E!11 | 2.412E!11 | 3.000E!03 | 8.040E!09 | 0.00 |
| Cobalt | 7.699E+02 | 2.571E!11 | 1.979E!08 | 0.000E+00 | — | — |
| Copper | 6.045E+02 | 2.571E!11 | 1.554E!08 | 0.000E+00 | — | — |
| Cyclohexane | 7.504E+03 | 2.571E!11 | 1.929E!07 | 5.700E+00 | 3.384E!08 | 0.00 |
| Cyclohexanone | 7.028E+03 | 2.571E!11 | 1.807E!07 | 5.000E+00 | 3.614E!08 | 0.00 |
| Ethyl acetate | 2.982E+03 | 2.571E!11 | 7.666E!08 | 9.000E!01 | 8.517E!08 | 0.01 |
| Ethyl benzene | 9.939E+02 | 2.571E!11 | 2.555E!08 | 2.900E!01 | 8.811E!08 | 0.01 |
| Fluoride | 7.699E+02 | 2.571E!11 | 1.979E!08 | 0.000E+00 | — | — |
| Iron | 1.721E+03 | 2.571E!11 | 4.426E!08 | 0.000E+00 | — | — |
| Lead | 0.000E+00 | 2.571E!11 | 0.000E+00 | 0.000E+00 | — | — |
| Manganese | 4.869E+02 | 2.571E!11 | 1.252E!08 | 1.400E!05 | 8.941E!04 | 88.14 |
| Mercury | 1.555E!01 | 2.571E!11 | 3.999E!12 | 8.600E!05 | 4.650E!08 | 0.00 |
| Methanol | 2.222E+03 | 2.571E!11 | 5.714E!08 | 5.000E!01 | 1.143E!07 | 0.01 |
| Methyl ethyl ketone | 1.623E+02 | 2.571E!11 | 4.173E!09 | 2.900E!01 | 1.439E!08 | 0.00 |
| Methyl isobutyl ketone | 8.889E+02 | 2.571E!11 | 2.285E!08 | 2.300E!02 | 9.937E!07 | 0.10 |
| Methylene chloride | 6.873E+00 | 2.571E!11 | 1.767E!10 | 8.600E!01 | 2.055E!10 | 0.00 |
| Nickel | 4.445E+02 | 2.571E!11 | 1.143E!08 | 0.000E+00 | — | — |
| N-nitrosodimethylamine | 8.335E!02 | 2.571E!11 | 2.143E!12 | 0.000E+00 | — | — |
| Phenol | 2.43E+03 | 2.57E-11 | 6.25E-08 | 6.00E-01 | 1.04E!07 | 0.1 |
| Pyridine | 4.321E+00 | 2.571E!11 | 1.111E!10 | 1.000E!03 | 1.111E!07 | 0.01 |
| Selenium | 8.889E!01 | 2.571E!11 | 2.285E!11 | 0.000E+00 | — | — |
| Silver | 2.963E+00 | 2.571E!11 | 7.618E!11 | 0.000E+00 | — | — |
| Tetrachloroethylene | 5.220E!01 | 2.571E!11 | 1.342E!11 | 1.100E!01 | 1.220E!10 | 0.00 |
| Thallium | 2.553E+01 | 2.571E!11 | 6.564E!10 | 0.000E+00 | — | — |
| Toluene | 1.406E+03 | 2.571E!11 | 3.614E!08 | 1.100E!01 | 3.285E!07 | 0.03 |
| Trichloroethylene | 4.729E!01 | 2.571E!11 | 1.216E!11 | 6.000E!03 | 2.026E!09 | 0.00 |
| Vanadium | 2.630E+02 | 2.571E!11 | 6.760E!09 | 0.000E+00 | — | — |
| Xylene | 4.445E+03 | 2.571E!11 | 1.143E!07 | 2.000E!01 | 5.714E!07 | 0.06 |
| Zinc | 1.721E+03 | 2.571E!11 | 4.426E!08 | 0.000E+00 | — | — |
| **Total** | | | | | **1.014E!03** | **100.00** |

## Step 8: Determine an Action Level for Lead

Of the COCs currently applicable to Tanks WM-184, WM-185, and WM-186, only lead does not have a reference dose or a slope factor. The following discussion offers an approach for establishing an action level for lead. Soil screening guidance (EPA 2001) suggests a lead soil concentration of 400 mg/kg based on *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities* (EPA 1994). The liquid lead concentration is calculated using the definition of $K_d$. The $K_d$ value is the ratio of the soil concentration to the liquid concentration. Thus, the action level is calculated by dividing the suggested soil concentration for lead by the $K_d$. The $K_d$ of lead is 100 $cm^3/g$ (EPA 1996). With these values, lead action level is calculated at 4 mg/L.

# REFERENCES


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# Appendix C

# Piping List and Associated Equipment

# Appendix C
# Piping List and Associated Equipment

Tables C-1 through C-6 list the piping associated with Tanks WM-184, WM-185, and WM-186, and describe past use, point of origin and termination, and function. Tables C-1 through C-3 list the piping that must be decontaminated for Hazardous Waste Management Act/Resource Conservation and Recovery Act closure for Tanks WM-184, WM-185, and WM-186, respectively. Tables C-4 through C-6 list the piping that has hazardous waste for Tanks WM-184, WM-185, and WM-186, respectively. These pipes will be taken out of service, but decontamination is unnecessary.

Table C-1. WM-184 RCRA closure lines.

| Number | Description | Point of Origin | Point of Termination | Comments |
|---|---|---|---|---|
| 10” VGA-605 | Offgas line 10” VGA-605 | Tank WM-184 | CPP-723 | |
| 1” DCN-609 | Decon line for riser WM-184 TR-56 | Exterior of WM-184 riser TR-56 | WM-184 riser TR-56 and WM-184 | |
| 1” DCN-610 | Decon line for riser WM-184 TR-55 | Exterior of WM-184 riser TR-55 | WM-184 riser TR-55 and WM-184 | |
| 1” DCN-611 | Decon line for riser WM-184 TR-58 | Exterior of WM-184 riser TR-58 | WM-184 riser TR-58 and WM-184 | |
| 1” DCN-612 | Decon line for riser WM-184 TR-57 | Exterior of WM-184 riser TR-57 | WM-184 riser TR-57 and WM-184 | |
| 3” PWA-630 | Process line from A7 to tank WM-184 | Valve Box A7 | Tank WM-184 | Capped in Valve Box A7; grout with valve box |
| 3” PWA-631 | Process line from A7 to tank WM-184 | Valve PUV-WM-22 in valve box A7 | Tank WM-184 | Decon and grout |
| 2” PUA-638 | South vault sump SR-23 Jet-WM-537 transfer line | WM-184 vault south sump SR-23 Jet-WM-537 discharge | VES-WM-184 | Decon only |
| 2” PUA-639 | North vault sump SR-22 Jet-WM-536 transfer line | WM-184 north vault sump SR-22 Jet-WM-536 discharge | VES-WM-184 | Decon only |
| ½” PUA-642 | Drain line for 10” VGA-605 | 10” VGA-605 | VES-WM-184 | |
| 1” PUA-657 | Drain line for CPP-723 into WM-184 south vault sump SR-23 | CPP-723 Trench | Tank WM-184 south vault sump SR-23 | Never been used, no action required. |
| 1” PUA-658 | Drain line from Valve Box A7 | Valve Box A7 | 1” PUA-657 | Decon only |
| 3” PUA-1037 | Process discharge line into WM-184 | Valve Box C16 | VES-WM-184 | Decon and grout |
| 2” PUA-1037 | Tank WM-184 Jet-WM-584-1A discharge | VES-WM-184 Jet-WM-584-1A | Valve Box C16 | Decon and grout |
| 2” PUA-1093 | Tank WM-184 jet pump 548-1B discharge | VES-WM-184 Jet-WM-584-1B | Valve Box C16 | Decon and grout |
| 1-1/4” PLA-104706 | North vault sump SR-22 Jet-WM-584-4 transfer line | WM-184 north vault sump SR-22 Jet-WM-584-4 discharge | Valve Box C16 connection with 1 ½”-PLA 104710 | Decon and grout |

Table C-2. Tank WM-185 RCRA closure lines.

| Number | Description | Point of Origin | Point of Termination | Comments |
|---|---|---|---|---|
| 3” PUA-208 | Process waste line discharge into Tank WM-184 | 3” PUA-1030 in Valve Box B3 | VES-WM-185 | |
| 1 ½” CRN-1001 to 1030 | Cooling solution return | VES-WM-185 cooling coils | CPP-634 cooling solution return manifold | |
| 1 ½” CSN-1001 to 1031 | Cooling solution supply | CPP-634 cooling solution supply manifold | VES-WM-185 cooling coils | |
| 10” VGA-1002 | Vessel Offgas line | Condenser HE-WM-383 in CPP-722 | VES-WM-185 center manway | |
| 2” DCA-1008 | Decon line for TR-4 riser | Hose connection external to tank riser TR 4 | TR 4 Pipe | |
| 2” DCA-1009 | Decon line for TR-2 riser | Hose connection external to tank riser TR 2 | TR 2 Pipe | |
| 2” DCA-1010 | Decon line for TR-1 riser | Hose connection external to tank riser TR 1 | TR 1 Pipe | |
| 2” DCA-1011 | Decon line for TR-3 riser | Hose connection external to tank riser TR 3 | TR 3 Pipe | |
| 1 ½” PUA-1022 | Condenser HE-WM-383 drain | CPP-722 PIT, from HE-WM-383 | VES-WM-185 | |
| 1” PUA-1023 | Valve Boxes B3 and B4 drains to south vault sump SR-2 | Valve Boxes B3 and B4 | South vault sump, SR-2 | Decontaminated and permanently capped. |
| 2” PUA-1024 | South vault sump SR2 jet pump WM-585-1 discharge line | South vault sump SR2 jet pump 585-1 discharge line | VES-WM-185 | Decon only |
| 2” PUA-1027 | Tank WM-185 north vault sump SR-1 Jet Pump 585-2 transfer to Tank 185 | CPP-785 north vault sump SR-1 jet pump 585-2 discharge | VES-WM-185 | Decon only |
| 3” PUA-1028 | Process waste line discharge into Tank WM-185 | DCV-WM-8 in Valve Box B3 | VES-WM-185 | |
| 3” PUA-1029 | Process waste line discharge into Tank WM-185 | 3” PUA-1005 in Valve Box B3 | VES-WM-185 | |
| 2” PUA-1038 | Process waste transfer line from jet pump WM-585-3B discharge in TR-11 | Tank WM-185 TR-11 jet pump WM-585-3B | 3” PUA-1038 in Valve Box C14 | |
| 2” PUA-1094 | Process waste transfer line from jet pump WM-585-3A discharge in TR-11 | Tank WM-185 TR-11 jet pump WM-585-3A | 3” PUA-1038 in DVB-WM-PW-C14 | |
| 1 ¼” PLA-104707 | Steam jet WM-585-4 discharge line | South vault sump SR2 jet pump 585-4 | 1 ½” PLA-104710 in Valve Box C16 | |
| 1 ¼” PLA-104708 | South vault sump SR4 jet pump 586-4 discharge | South vault sump SR4 jet pump 586-4 | 1 ½” PLA-104 in Valve Box C16 | |
| 1” PLA-104783 | Valve Box C14 drain | Valve Box C14 | 1 PLA-104773 | Decon only |

Table C-3. Tank WM-186 RCRA closure lines.

| Number | Description | Point of Origin | Point of Termination | Comments |
|---|---|---|---|---|
| 10” VGA-1001 | Vessel offgas line | VES-WM-186 center manway | Control Pit #1 | |
| 1” DCA-1001 | Valve Box B2 connection to 3” PUA-1016 | Valve Box B2 | 3” PUA-1016 | |
| 2” DCA-1004 | Decon line for riser TR6 | Exterior of riser TR6 | WM-186 TR6 riser | |
| 2” DCA-1005 | Decon line for riser TR7 | Exterior of riser TR7 | WM-186 TR7 riser | |
| 2” DCA-1006 | Decon line for riser TR8 | Exterior of riser TR8 | WM-186 TR8 riser | |
| 2” DCA-1007 | Decon line for riser TR5 | Exterior of riser TR5 | WM-186 TR5 riser | |
| 3” PUA-1013 | Process line from B2 to Tank WM-186 | B2 (with cap) | Tank WM-186 | |
| ½” PUA-1015 | 10” VGA-1001 drain line to VES-WM-186 | 10” VGA-1001 | VES-WM-186 | |
| 3” PUA-1016 | Process line from Valve Box B2 to tank WM-186 | 1” CA-1001 | Tank WM-186 | |
| 1” PWA-1017 | Control Pit #1 drain line to north vault sump SR3 | Control Pit #1 | North vault sump SR3 | |
| 2” PUA-1019 | South vault sump SR4 jet pump 586-1 discharge to tank WM-186 | South vault sump SR4 jet pump 586-1 | VES-WM-186 | Decon only |
| 2” PUA-1021 | North vault sump SR3 jet pump 586-2 discharge to VES-WM-186 | North vault sump SR3 jet pump 586-2 | VES-WM-186 | Decon only |
| 1” PLA-1031 | Valve Boxes B1 and B2 drain line to south vault sump SR4 | Valve Boxes B1 and B2 | South vault sump SR4 | |
| 2” PUA-1039 | Tank jet pump 586-3B discharge line | Tank jet pump 586-3B | 3” PUA-1039 in Valve Box C19 | |
| 3” PUA-1040 | Process line from B2 to tank WM-186 | 3” PUA-1014 in Valve Box B2 | Tank WM-186 | |
| 2” PUA-1095 | Tank jet pump 586-3A discharge line | Tank jet pump 586-3A | 3” PUA-1039 in Valve Box C19 | |
| 1 ¼” PLA-104708 | South vault sump SR4 jet pump 586-4 discharge | South vault sump SR4 jet pump 586-4 | 1 ½” PLA-104 in Valve Box C16 | |
| 1” PLA-104773 | Main collection line for valve box drains | Valve boxes | Valve Box C12 | Decon only |
| 1” PLA-104782 | Valve Box C19 drain to 1” PLA-104773 | Valve Box C19 | 1” PLA-104773 | Decon only |
| 1” PWA-1023 | Valve box drain | Valve Box B4 | South sump of WM-185 vault | Decon only |
| 3” PWA-204 | Transfer line | WL 101 | WM-181, 184, 186 | Decon only |

Table C-4. Tank WM-184 non-RCRA closure lines.

| Number | Description | Point of Origin | Point of Termination | Comments |
|---|---|---|---|---|
| 1 ½" HSA-607 | Steam to south vault sump SR 23 jet pump 537 | Valve Box C17 | SR 23 south vault sump Jet-WM-537 | |
| 1 ½" HSA-608 | Steam to north vault sump SR 22 | Valve Box C17 | SR 22 south vault sump Jet-WM-536 | |
| 1" DCA-627 | Process waste line | | Capped east side of WM-184 | Line has never been used |
| 1" DCA-628 | Process waste line | | Capped east side of WM-184 | Line has never been used |
| 1" DCA-629 | Process waste line | | Capped east side of WM-184 | Line has never been used |
| 1" PUA-659 | Process waste line | | Capped east side of WM-184 | Line has never been used |
| 3" PWA-635 | Spare process line | | Capped east side of WM-184 | Line has never been used |
| 3" PWA-636 | Process waste line | | Capped east side of WM-184 | Line has never been used |
| 3" PWA-637 | Process waste line | | Capped east side of WM-184 | Line has never been used |
| 1 ½" HSA-1016 | Steam supply to tank jet pump, 584-1A | CPP-628 | Jet-WM-584-1A | |
| 1 ½" HSA-1017 | Steam supply to tank jet pump, 584-1B | CPP-628 | Jet-WM-584-1A | |
| ½" LAA-104715 | Low pressure air line | CPP-628 | SR-22 north sump | |
| ½" LAA-104716 | Low pressure air line | CPP-628 | SR-22 north sump | |
| 1" HAS-104729 | Steam supply to vault jet pump, 584-4 | Valve Box C17 | SR-22 north vault sump jet pump, 584-4 | |
| (9) ¼" Instrument Lines | Instrument conduit | | | |
| 1 ½" Instrument Conduit | Instrument conduit | | | |
| 2" Conduit | Instrument conduit | | | |

Table C-5. Tank WM-185 non-RCRA closure lines.

| Number | Description | Point of Origin | Point of Termination | Comments |
|---|---|---|---|---|
| 1 ½” HSA-1006 | Steam to vault south sump SR2 Jet-WM-585-1 | Valve Box C13 line 1” HSN-104730 | Vault south sump SR2 Jet-WM-585-1 | |
| 1 ½” HSA-1007 | Steam to vault north sump SR1 Jet-WM-585-2 | Valve Box C13 line 1” HSN-104730 | Vault north sump SR2 Jet-WM-585-2 | |
| 1 ½” HSA-1018 | Steam to tank JET-WM-585-3B | CPP-628 | Tank Jet-WM-585-3B | |
| 1 ½” HSA-1019 | Steam to tank JET-WM-585-3A | CPP-628 | Tank Jet-WM-585-3A | |
| 1” HSA-104733 | Steam to vault south sump SR2 Jet-WM-585-4 | Valve Box C13 line 1” HSN-104730 | Vault south sump SR2 Jet-WM-585-4 | |
| (18) ¼” Instrument Lines | | | | |
| 1 ½” Conduit | | | | |

Table C-6. Tank WM-186 non-RCRA closure lines.

| Number | Description | Point of Origin | Point of Termination | Comments |
|---|---|---|---|---|
| 1 ½" HSA-1004 | Steam to vault south sump SR4 Jet-WM-586-1 | Valve Box C13 | Vault south sump SR4 Jet-WM-586-1 | |
| 1 ½" HSA-1005 | Steam to vault north sump SR3 Jet-WM-586-2 | Valve Box C13 | Vault north sump SR3 Jet-WM-586-2 | |
| 1 ½" HSA-1020 | Steam to tank JET-WM-586-3B | CPP-628 | Tank Jet-WM-586-3B | |
| 1 ½" HSA-1021 | Steam to tank JET-WM-586-3A | CPP-628 | Tank Jet-WM-586-3A | |
| 1" HSA-104734 | Steam to vault south sump SR4 Jet-WM-586-4 | Valve Box C13 | Vault south sump SR4 Jet-WM-586-4 | |
| (18) ¼" Instrument Lines | | | | |
| 1 ½" Conduit | | | | |

# Appendix D

# Statistical Analysis for Tank Farm Closure

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# Statistical Analysis for Tank Farm Closure

## D-1. INTRODUCTION

Several different statistical methods will be applied to the Tank Farm Facility (TFF) closure data. There are two primary objectives with regard to the statistical analysis that will be performed on the data. The first objective is to determine if the constituents of interest are present in levels greater than the specified action level. Confidence intervals will be used for this analysis. The second objective is to determine if the contents of the tanks and the vault sumps came from the same population. This will be done by performing Analysis of Variance (ANOVA) on the data from the samples collected in the vault sumps at Tanks WM-184, WM-185, and WM-186 and the data from samples collected within the two tanks. ANOVA also will be used when more data are obtained from other tanks. Five samples will be taken from each tank and one sample from each of the two vault sumps for each tank (a total of six samples from the vault sumps). This provides a total of 21 samples from Tanks WM-184, WM-185, and WM-186.

## D-2. CONFIDENCE INTERVALS

Confidence intervals will be used to determine if any of the constituents of concern in the tanks or the vaults exceed the specified action levels. This is done by constructing a 90% confidence interval for the concentration of each constituent in each tank and comparing the upper confidence limit with the specified action level. If the upper confidence limit is less than the action level, then the constituent is considered to be present in levels less than the action level. If the upper confidence limit is greater than the action level, then it is assumed that the constituent is present in concentrations that are greater than the action level and appropriate action will be taken.

### D-2.1 Construction of a Confidence Interval

A confidence interval is constructed using the sample mean and standard deviation of the data. For each constituent, the mean concentration, $\overline{X}$, is calculated using the equation

$$\overline{X} = \frac{\sum_{i=1}^{n} X_i}{n} \tag{D-1}$$

where

$n$ = the number of observations in the data set

$X_i$ = the $i^{th}$ observation in the data set.

The standard deviation, $s$, is calculated using the equation

$$s^2 = \frac{\sum_{i=1}^{n}\left(X_i - \overline{X}\right)^2}{n-1} \tag{D-2}$$

The confidence interval is calculated using the expression

$$\overline{X} \pm t_{1-\alpha,n-1}\sqrt{\frac{s^2}{n}}$$

where

$t_{1-\alpha,n-1}$ = the *t*-statistic at *1-α* with *n-1* degrees of freedom

So

$$UCL = \overline{X} + t_{1-\alpha,n-1}\sqrt{\frac{s^2}{n}} \tag{D-3}$$

where

*UCL* = upper confidence limit.

The *t*-statistic can be found on a *t*-table or from a statistical software package. In the case of the analysis for the TFF closure, $\alpha$=0.05 since the 95% upper confidence limit is being used. This is the significance level of a statistical hypothesis test. Essentially comparing the upper limit of a confidence interval to the action level is comparable to performing a one-sample *t*-test of the sample mean against the action level at the $\alpha$=0.05 level. (The 95% upper confidence limit is the upper limit of a 90% confidence interval. Since it is only the upper confidence limit that is being compared to the action level, setting α=0.05 gives the test an overall significance level of 0.05.)

## D-2.2 Use of the Confidence Interval

Once the confidence interval has been calculated for a given constituent concentration, a comparison can be made against the action level for that constituent. The general rule is if

$$\overline{X} + t_{1-\alpha,n-1}s < AL \tag{D-4}$$

where

*AL* = action level

then it can be confidently concluded that the constituent concentration is less than the action level. However, if

$$\overline{X} + t_{1-\alpha,n-1}s \geq AL \tag{D-5}$$

then it cannot be concluded that the constituent concentration is less than the action level. In this situation, it is assumed that the constituent concentration exceeds the action level and the appropriate action should be taken.

A confidence interval will be constructed for every constituent of concern in each tank and in the vault sumps for each tank. This means if there are 10 constituents of interest, 40 confidence limits will be calculated and compared to the appropriate action levels.

Let's work through an example calculation to determine the 95% upper confidence limit. If the sample data are $\overline{X} = 0.87$, $s^2 = 0.073$, $t_{0.05,9} = 1.833$, and $UCL = 0.87 \pm 0.1565$, which corresponds to an upper confidence limit at 1.03 mg/L, then the calculation yields the following:

Liquid Arsenic Sample Data (Example)

| Sample No. | Concentration (mg/L) | Sample No. | Concentration (mg/L) |
|---|---|---|---|
| 1 | 0.79 | 6 | 0.98 |
| 2 | 0.85 | 7 | 0.87 |
| 3 | 0.92 | 8 | 0.78 |
| 4 | 0.75 | 9 | 0.88 |
| 5 | 0.80 | 10 | 1.06 |

Since the action level for liquid arsenic has been set at 1.05, it can be determined that for these 10 samples, there is 95% confidence that the true mean is less than 1.03 mg/L. This method is adapted from *Test Methods for Evaluating Solid Wastes*, *Physical/Chemical Methods* EPA SW-846 (1998).

## D-2.3 Assumptions of Confidence Intervals

When constructing a confidence interval, the data must be approximately normally distributed to meet the assumptions of the confidence interval. Since the *t*-statistic is used to generate the confidence interval, the interval is robust against certain variations from the normal distribution. However, the data still need to be symmetric about the mean and free of outliers. Since the *t*-statistic is robust against slight variations from the normal distribution, performing a hypothesis test to verify the normality of the data is not appropriate. Statistical tests that are used to determine if a data set follows a certain distribution are highly sensitive to variations of the data from the distribution in question. Because of this, data that fail to meet the requirements of the statistical test for normality may still produce a reliable confidence interval. In fact, if a statistical test for determining the normality of the data does show that the data are normal (i.e., the null hypothesis is not rejected), then the *z*-statistic should be used in the confidence interval instead of the *t*-statistic. The normality of the data can be better assessed by examining the summary statistics of the data and through graphical methods such as histograms.

Another assumption that is made when constructing a confidence interval is that the sample mean and the standard deviation are independent. This is always the case if the data are truly normally distributed. Because of this, it is assumed that this assumption is met if the data appear to be approximately normally distributed.

## D-2.4 Using the Lognormal Transformation

Since the type of data that will be obtained from the TFF tanks is non-negative, it is likely that the data will be log normally distributed rather than normally distributed. This means that the natural log of the data points have a normal distribution. The traditional method for analyzing lognormal data is to take the log of all of the data points and perform the statistical analysis on the transformed data. Any methods that are appropriate for the normal distribution can be applied to the transformed data. However, this can pose some complications with some analytical methods. For example, a confidence interval that is generated using the transformed data is accurate for estimating the mean of the transformed data, but the interval cannot be transformed back to the scale of the raw data to estimate the mean of the raw data. However, the *t*-test can be accurately performed on the transformed data against a cutoff value such as the action level of a constituent. The test is performed by taking the log of the raw data and calculating the mean and standard deviation using the transformed data. These values are then used to perform a *t*-test against the log of the action level. Because the confidence interval is only being used to conduct a *t*-test for the data from the TFF, the results obtained by comparing the 95% upper confidence limit of log transformed data against the log of the action level is as accurate a test as comparing the 95% upper confidence limit against the action level if the raw data were truly normally distributed.

It is possible that the data that will be obtained from the TFF will be neither normal nor log normally distributed. If this is the case, other transformations will be attempted on the data to see if normality can be achieved with some transformation. The methods described above will be applied to the transformed data. As with the natural log transformation of the data, confidence intervals can be used to perform a *t*-test on the transformed data.

## D-3. ANALYSIS OF VARIANCE (ANOVA)

The second type of analysis of interest is the use of one-way ANOVA to determine if the contents of the tanks and vault sumps came from the same population. A separate ANOVA will be performed for each constituent of concern. One-way ANOVA is similar to the *t*-test. In fact, the *t*-test is a special case of one-way ANOVA. ANOVA is a statistical hypothesis test for determining if the means of several groups are different from each other. In the situation of the tanks and vault sumps in the TFF, each tank or vault sump is considered a group. ANOVA is used instead of a *t*-test because many different *t*-tests would need to be performed to make all of the desired comparisons. This will increase the significance level, $\alpha$. Since multiple tests would be run on the same set of data, the significance level would no longer be 0.05. This is because the significance level applies to the chance of achieving significance in the analysis, not just one test. Although the chance of making a Type I error (rejecting the null hypothesis when it is in fact true) on a single test is only 0.05, the chance of making a Type I error somewhere in at least one of several tests is much greater than 0.05. ANOVA is a more appropriate way to deal with this type of situation.

### D-3.1 Use of ANOVA

As stated above, ANOVA is a test of the means between several different groups. The null hypothesis is that there is no difference in analyte concentrations between all of the tanks and vault sumps. This means that the contents of the tanks and vault sumps came from the same population. The alternative hypothesis is that there is a difference in analyte concentration levels between the tanks and vault sumps. This means that the contents of the tanks and vault sumps do not come from the same population. Note that the alternative hypothesis does not specify which tanks or sump vaults are different from each other. It could be that all the tanks and vault sumps have significantly different constituent concentrations or it could be that only one of the tanks or vault sumps has a different mean concentration than one, or all, of the other tanks or vault sumps. If the P-value associated with the ANOVA test indicates that there is a significant difference in concentration levels between the tanks and vault sumps (i.e., $P < 0.05$), then multiple means comparison testing will be used to determine which tanks and/or vault sumps are different from each other. Just because significance is achieved using ANOVA, it does not necessarily mean that there is significant contamination in the tanks or vault sumps. It could be that two of the post-decontamination residuals in the tanks have different mean concentrations from each other, but that none of the tanks or vault sumps have constituent concentrations that are significantly greater than the action level.

The results of the ANOVA test are presented in a table that looks like this:

| Model | DF | SS | MS | F | P |
|---|---|---|---|---|---|
| Group | DFG | SSG | MSG | F | P |
| Error | DFE | SSE | MSE | | |
| Total | DFT | SST | | | |

In the table,

DFG = number of tanks and sump vaults –1

DFT = total number of samples –1

DFE = DFT – DFG

$$SSG = n\sum_{groups}(\bar{x}_i - \bar{x})^2$$

$$SST = \sum_{obs}(x_{ij} - \bar{x})^2$$

SSE = SST – SSG

MSG = SSG/DFG

MSE = SSE/DFE

F = MSG/MSE

where

$n$ = the total number of samples taken from each tank

DFX = the degrees of freedom for term X

SSX = the sum of squares for the term X

MSX = the mean square for the term X

F = the F-statistic

P = P-value.

The P-value can be found from an *F*-table. The degrees of freedom in the numerator are DFG and the degrees of freedom in the denominator are DFE (this is only pertinent if you are in fact going to look up the P-value on a table).

The P-value is the number that is of primary interest. If P is less than 0.05, then the null hypothesis is rejected and there is some difference between the analyte concentrations in the tanks and/or sump vaults. If P is greater than or equal to 0.05, then there is not sufficient evidence to reject the null hypothesis and it can be concluded that the contents of the tanks and vault sumps come from the same population.

ANOVA can be used to analyze the data from Tanks WM-184, WM-185, and WM-186 and the corresponding vault sumps, and can also be used to analyze the data as more data are obtained. A separate ANOVA needs to be generated for each constituent of concern.

One issue with this particular data set is that the data are unbalanced. This means that each group does not have the same number of observations in it. Each of the tanks will consist of 5 observations per tank. Each vault sump group will contain 2 observations. There are two different ways to handle this situation. One way is to analyze the tanks separately from the vault sumps. The benefit of doing this is that the design will be balanced and the mathematics will be simpler. The disadvantage is that a direct comparison between the tanks and the vault sumps cannot be made. The other method is to use type III sums of squares to generate the *F*-statistics instead of the type I sums of squares. The advantage of this method is that all of the tanks and vault sumps can be analyzed in the same design and therefore they all can be compared against each other. The disadvantage is that the equations for the sums of squares for ANOVA that are listed above are no longer applicable, so the mathematics become very complex in generating the sums of squares. However, since a computer will be used to perform all of the calculations, the mathematical complexity does not present a problem. It is recommended that all of the data be analyzed in the same model and that type III sums of squares are used to generate the *F*-statistics.

## D-3.2 Assumptions of ANOVA

Several assumptions are made when performing ANOVA on the data. They are as follows:

- The data are approximately normally distributed
- The groups have approximately equal variance
- The group mean and standard deviation are independent.

These assumptions need to be verified before the results of ANOVA can be considered reliable. Since ANOVA is based on the *F*-statistic, the test is robust against small variations from the normal distribution. However, the data do need to be symmetric and free of outliers. As with the confidence interval, the use of a statistical test to determine the normality of the data is not appropriate because it is far more conservative than is necessary for ANOVA (see Section D-2.3).

The normality assumptions can be verified through examining residual plots. Residual plots are generated by plotting the residuals against the predicted values generated from ANOVA and by plotting the residuals against the groups. A residual is calculated by subtracting the value predicted from the ANOVA model from the corresponding observed data value. Residual plots also are the standard method for determining if the groups have approximately equal variance. Normal-quantile plots and symmetry plots also can be used to assess symmetry, the presence of outliers in the data, and how close the data follow a normal distribution. A histogram of the residuals can also be examined to determine the normality of the data. These methods are sufficient for establishing that the normality assumption has been met. As with the confidence intervals, if the data look to be sufficiently normally distributed then it is assumed that the group mean and standard deviation are independent. This is because for data that are truly normal, the sample mean and standard deviation are always independent.

# D-4. REFERENCES

EPA, 1998, *Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods*, EPA SW-846, Revision 5, April.